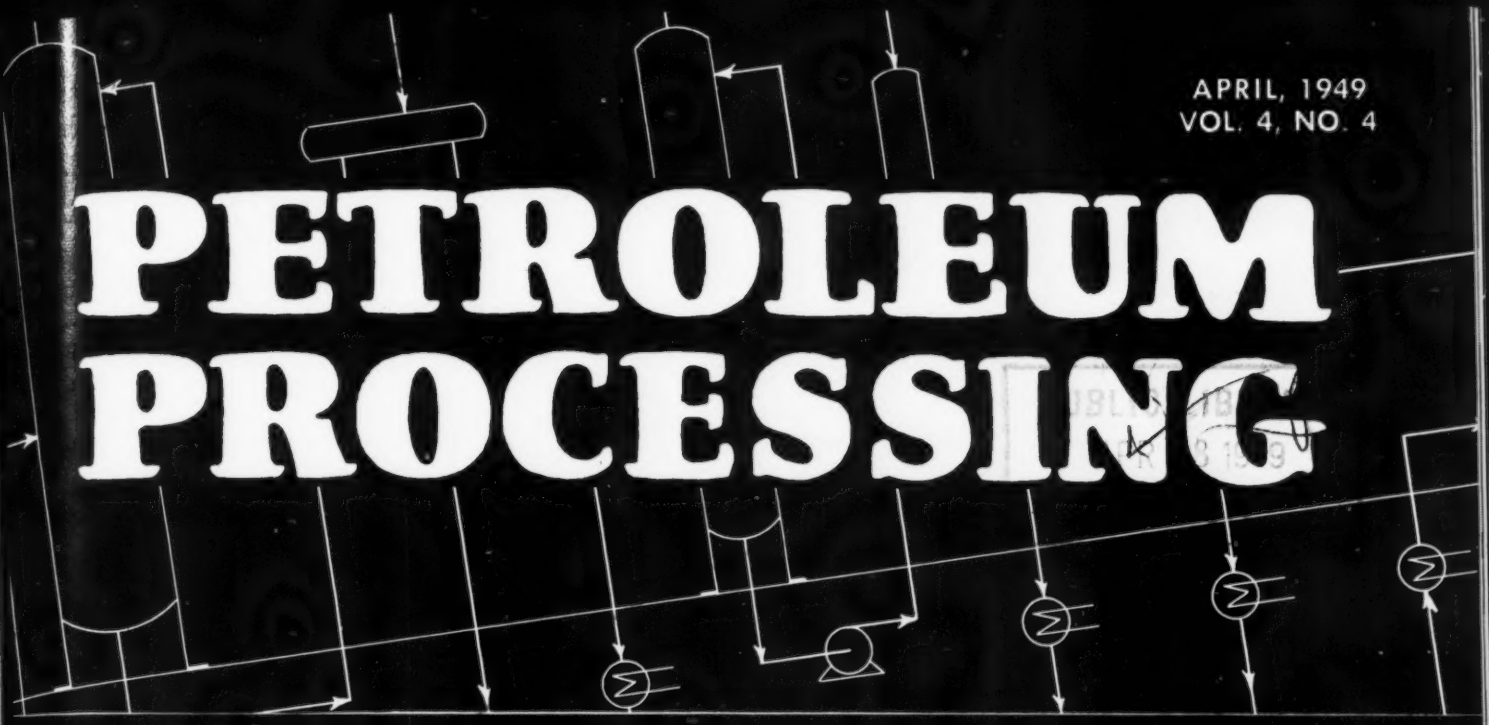
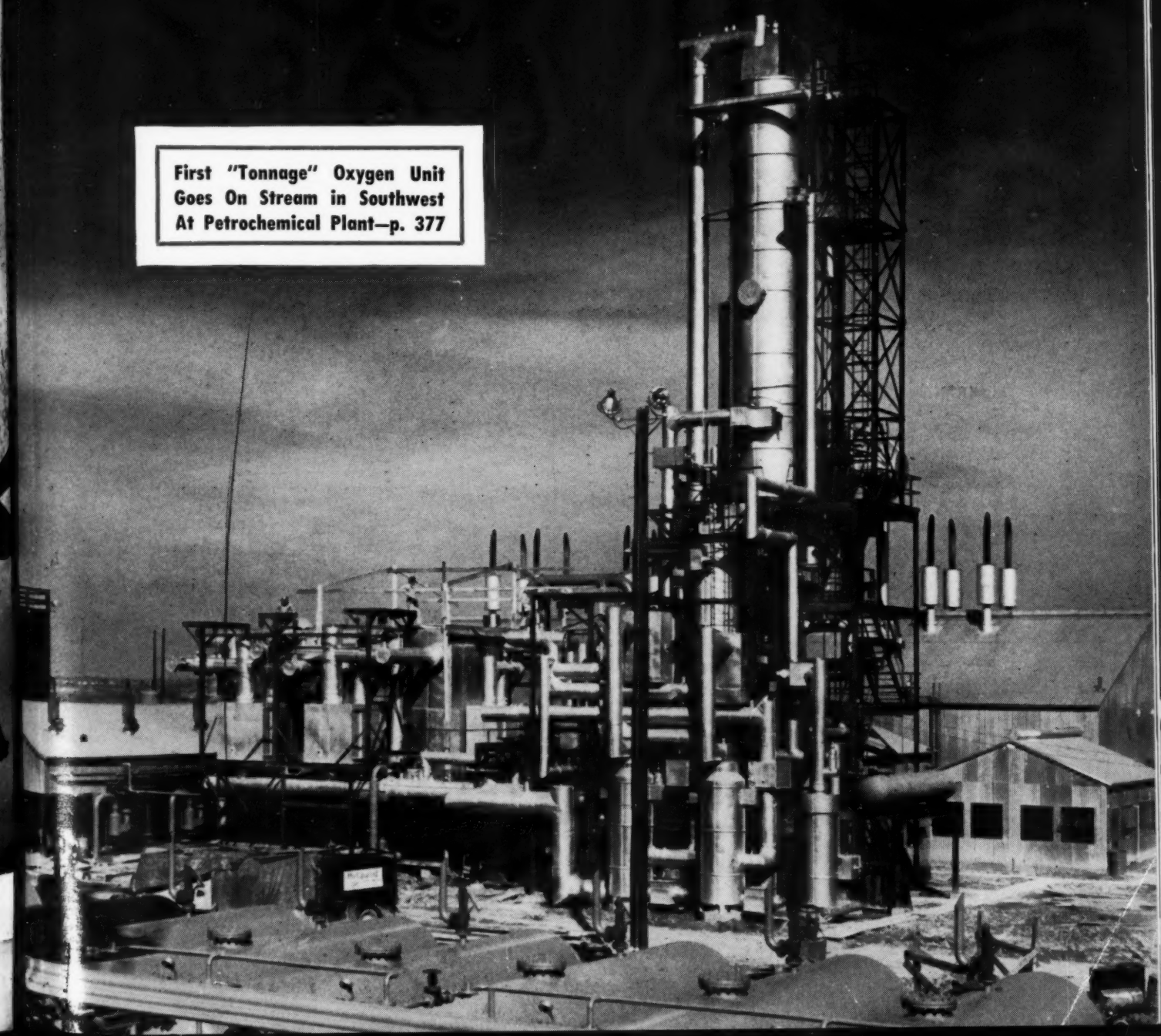
APRIL, 1949
VOL. 4, NO. 4

PETROLEUM PROCESSING

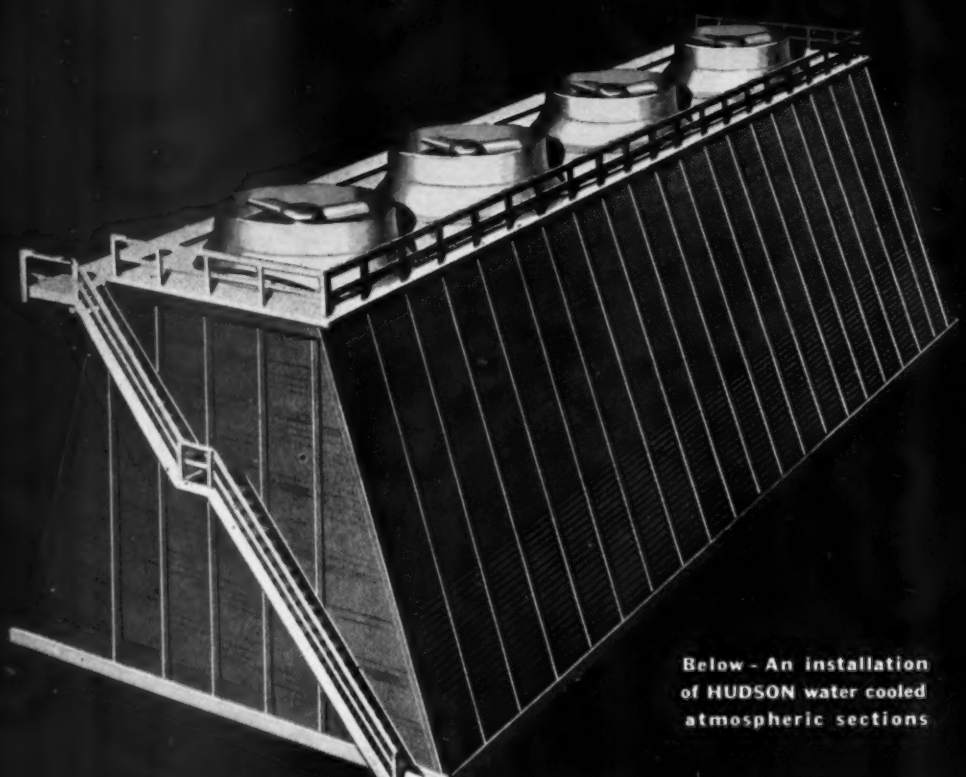


First "Tonnage" Oxygen Unit Goes On Stream in Southwest At Petrochemical Plant—p. 377



NEW HUDSON

Top Performance COOLING TOWERS



Below - An installation of HUDSON water cooled atmospheric sections

IMPROVED AIR FLOW AND AIR-WATER CONTACT

Unique deck design reduces air pressure drop and establishes positive counter current contact between air and water. Tapered sides of the tower eliminate dead space and decrease air turbulence.

LOWER OPERATING COST

Low pumping head and low fan horsepower result in perpetual power savings.

ECONOMY IN FABRICATION AND ERECTION

Prefabricated sections are designed for mass production and easy field assembly.

GREATER STRUCTURAL STRENGTH

Bridge truss type framework with improved timber connectors develops maximum strength in load bearing members.

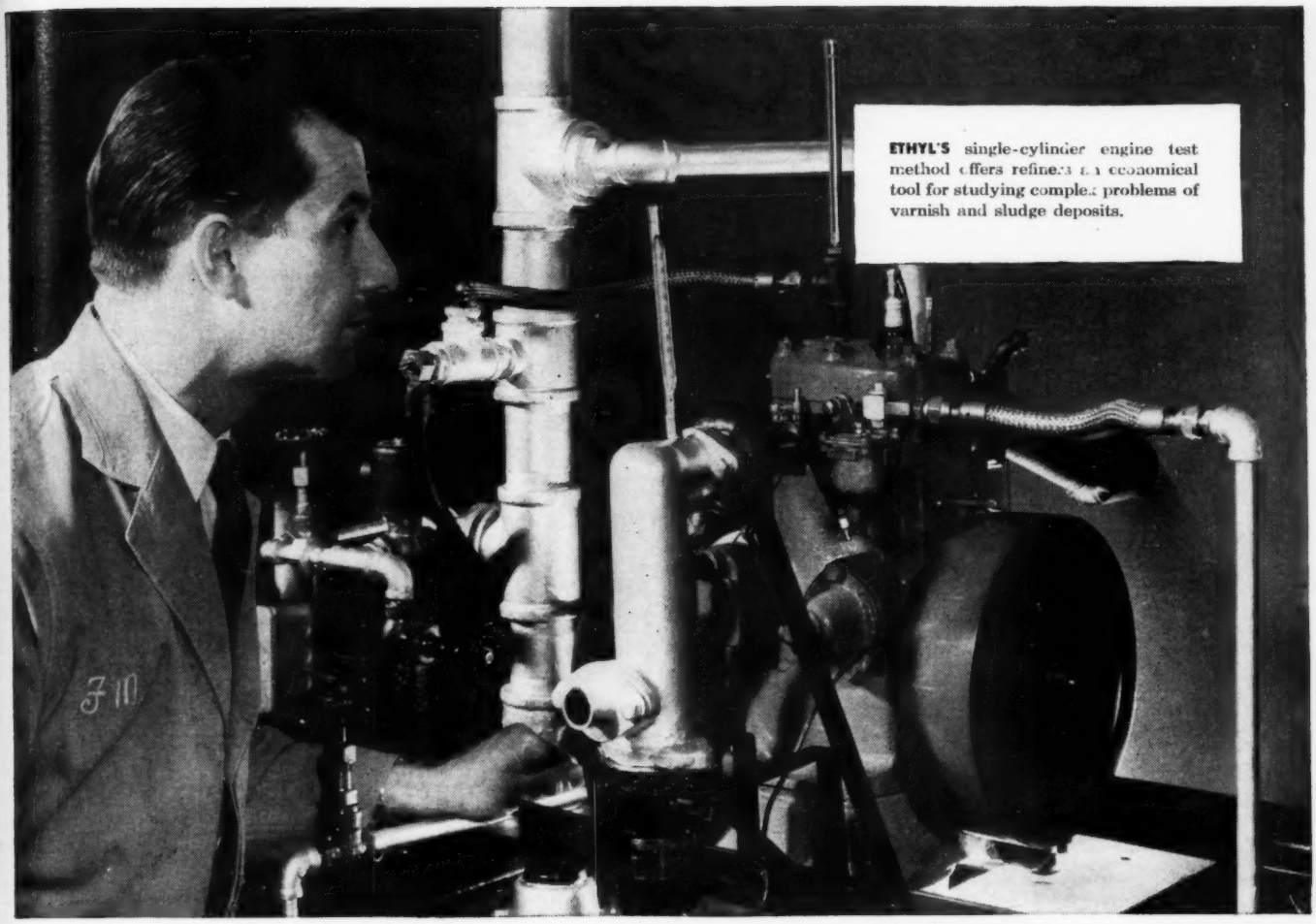
Undivided Responsibility

Complete integration in selection and design of cooling tower with coolers, results in cooling systems of minimum first cost and minimum operating cost... and the responsibility is undivided.

ENGINEERS *CONSTRUCTORS*

HUDSON ENGINEERING CORPORATION

FAIRVIEW STATION HOUSTON, TEXAS



ETHYL'S single-cylinder engine test method offers refiners an economical tool for studying complex problems of varnish and sludge deposits.

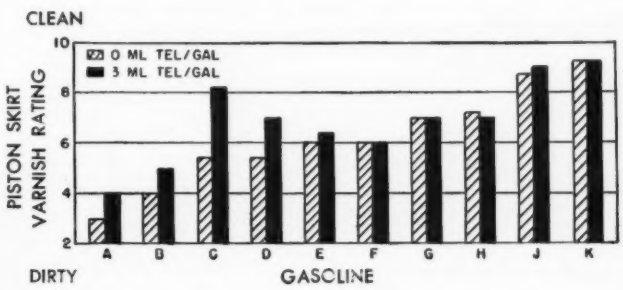
Exploring Engine Cleanliness

Recognizing engine cleanliness as part of the over-all problem of engines, fuels and lubricants, the Ethyl Laboratories have worked extensively in helping to build up a background of information on the factors contributing to the formation of varnish and sludge.

This work has accented the need for an economical test method which could be used for screening and preliminary tests.

An important contribution of Ethyl's research has been the development of a test method that permits the use of a smaller engine. This new test method requires fewer over-all man hours of work, does not involve expensive dynamometer equipment, and uses only fourteen gallons of gasoline—a real advantage in research on experimental fuels. The results obtained by these two methods are comparable.

Ethyl's comprehensive and continuous research program provides information that assists refiners directly in the economical production of satisfactory gasoline and furnishes basic data which serve as a foundation for development programs related to gasolines, engines, and crankcase oils.



Research on ten different fuels showed that the addition of "Ethyl" antiknock compound tended to reduce varnish deposits on piston skirts.

Since 1923—*continuous research to provide better antiknock service*

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The Wiggins Lodek Floating Roof

. . . designed specially for the storage of corrosive oil products. The entire under surface being in complete contact with the tank contents, no vapors are trapped or can collect beneath the roof.

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Write for bulletin FR-3 which gives further details on Wiggins Lodek Floating Roofs.

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VOL. 4, NO. 4 **APRIL, 1949**

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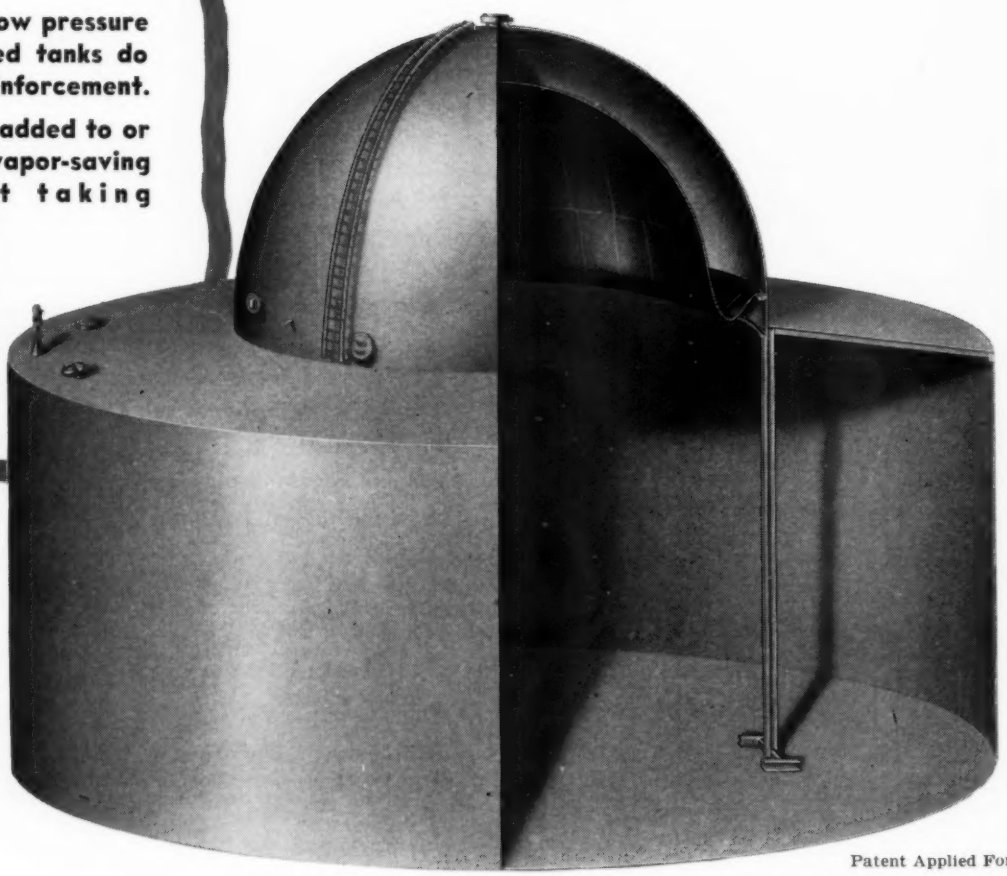
Some advantages of the new Vapordome Roof

- Easily installed as roof of new tank or roof of existing tank. Needs no ground space.
- Operates dependably in any climate. All moving parts are enclosed.
- Operates without cost, aside from ordinary maintenance.
- Operates at low pressure—inter-connected tanks do not require reinforcement.
- Tanks can be added to or taken out of vapor-saving system without taking Vapordome or inter-connected tanks out of service.
- Very low fire hazard.

Newest member of the Horton line

the HORTON Vapordome Roof

. . . provides an expansible vapor-space which prevents standing storage evaporation losses when installed on a new tank or an existing flat-bottom tank



Patent Applied For.

The Vapordome Roof is used to prevent standing storage evaporation losses from flat-bottom steel storage tanks. It consists of a lap-welded, cone-shaped steel roof with a butt-welded steel hemisphere at the center. A flexible membrane is attached by its outer edge to the equator of the Vapordome. When the air-vapor mixture inside the tank expands, this membrane moves upward to provide the additional capacity required without allowing vapor to escape from the tank. When decreasing temperature causes the vapor to contract, the membrane drops down.

The Vapordome is similar, in operation, to the Horton Vaporsphere. It can, however, be adapted more economically (a) when a flat-bottom tank is being reroofed, (b) when there is no ground space for a Vaporsphere, or (c) when a new tank is being installed to operate independently or as the central unit of a vapor-saving system. In other situations, the Vapordome Roof will efficiently reduce evaporation losses from products such as crude oil and gasolines. For complete details on the Vapordome Roof, call our nearest office.

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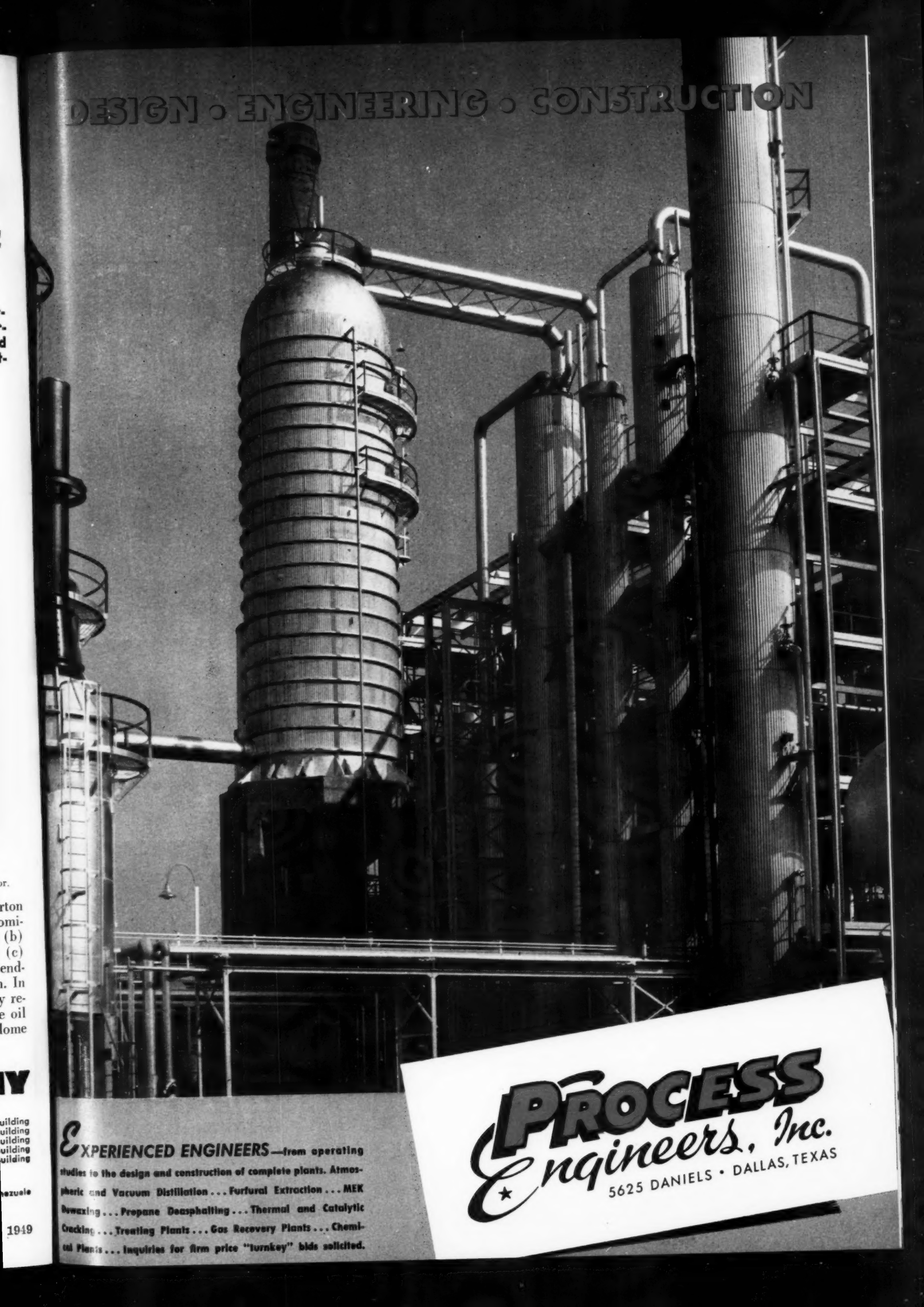

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WHEN PERFORMANCE COUNTS . . . CALL ON CYANAMID

What's Happening!

Important Current News Summarized for Refiners

CRUDE SITUATION

Military thinking reverses: The extent to which the petroleum industry, of its own efforts since the war ended, has added to available petroleum supplies has changed the outlook picture for the military authorities. Navy Undersecretary Kenny told the House Foreign Affairs Committee that the fuel requirements for a major war effort on the part of the U. S. now can be supplied from natural petroleum from this country and from other Western Hemisphere sources. Only 15 months ago Defense Secretary Forrestal said the U. S. would lack 2,000,000 b/d of being able to meet the requirements of another war.

Kenny's statement was described by Rep. Lodge (Conn.) as so "startling" that, if true, "we will have to revise all our thinking and so will all responsible authorities in Washington."

Production of crude oil in Canada may reach 400,000 b/d by 1953, ten times the present rate, due to the discovery of the Leduc field and other producing areas in western Canada, Joseph E. Pogue, vice-president Chase National Bank, told an investment dealers' association in that country. A large part of this oil may find its way into this country, he said, because the large Canadian markets in the east can be more economically supplied by oil from the U. S. and other foreign sources. Reserves already proven in the Leduc field are estimated as high as 130,000,000 bbls. Present Canadian refining capacity is around 275,000 b/d.

• • •

THROUGHPUT, 1949

Processing taxes proposed: Texas and Oklahoma legislators, casting about for means to increase state revenues with the least direct burden on taxpayers, revived the idea of a processing tax. This would levy 1c/gal. on "motor fuel", or material capable of being so used, produced within or imported into the states. Natural gasoline was specifically included and conceivably could be taxed twice, once when manufactured and again when blended into motor fuel.

Concurrently, bills were introduced in both states repealing or reducing the state gasoline tax, in anticipation of greater revenues from the new tax since both states export the greater portion of their refineries' output.

Oil industry leaders pointed out a logical result could be to limit refining and natural gasoline manufacturing in each state to just enough to meet the demand requirements there.

• • •

PROCESSES

A new catalytic reforming process, called "Platforming" because of its use of platinum, is announced by Universal Oil Products Co. for octane number improvement of all types of straight-run stocks in the gasoline boiling range, and also natural gasolines. The process is described as being like hydroforming in that hydrogen recycle is employed to suppress carbon formation; however, the operation is continuous and non-regenerative.

Further development of its catalytic desulfurization process by Union Oil Co. of California is announced in company's annual report. The process is described as "the most practical method yet devised for the removal of sulfur and nitrogen from crude oil and distillates." It converts the organically combined sulfur to hydrogen sulfide by contact with cobalt molybdate catalysts in the presence of hydrogen.

• • •

MARKETS, PRICES

Two salient developments in oil prices took shape in March: a further downtrend in kerosine, heating oil, Diesel and residual fuel prices; and an upturn in gasoline prices, particularly at the Gulf Coast. Wax also firmed along the Eastern Seaboard, and the weakness in lube oil demand was less marked.

Outlook appeared good for spring gasoline demand, marketwise. On the other hand, the price position of gasoline was said by some sources to be uncertain. Not only were gasoline stocks at record levels, but charging stock in the form of unsold distillates was in abundance in most refining districts.

Biggest price move of the month was Esso Standard's cut-back on distillates and residual fuel, ranging from 0.4 to 1c per gal., to all types of buyers

Information on these pages is obtained through the nation-wide news coverage services of PLATT'S OILGRAM NEWS

throughout its marketing territory, effective March 21. This move carried prices to lower levels at most points along the Atlantic coast from Charleston, S. C., north. Esso's cargo prices for kerosine and gas oil touched new low levels for business reported at the Gulf.

The following day, March 22, Esso advanced its gasoline prices 0.5c for domestic and export cargo business at the Gulf Coast, quoting 10c for regular, 11c for premium, and 9.75c for 70-72 oct. leaded.

First reduction in three months was reported during March in prices for South Texas lube oils, with some refiners reporting discounts up to 1c/gal. In other areas, some increase in lube demand was noted. Several refiners in Western Penna. cited that the French purchasing mission was in the market for 3,000 bbls. of 25 p.t. Penna.-grade bright stock. Some increases in orders from the jobbing trade also were reported.

• • •

PRODUCTS

The new type fuel for jet-propelled aircraft, AN-F-58 (JP-3), which has been under test by the Air Force and the Navy for about a year has become official, supplanting the former kerosine type (JP-1) fuel used. The new fuel is said to be basically a gasoline type, with an octane rating varying between 50 and 65, with larger volumes available from the crude processed than of the former fuel. The new fuel cannot be used in reciprocating engine aircraft, but jet-propelled planes, with modifications, can use standard high-octane gasoline.

Socony-Vacuum Oil Co., Inc. has introduced at its service stations a new heavy-duty type motor oil claimed to have exceptional oxidation resistance and chemical stability, powerful detergent action, and a high viscosity index. The oil, compounded entirely of solvent-extracted base oils, is the result of a three-year program of research.

• • •

EXPANSION, TRANSITION

Pan American Refining has indefinitely suspended its $1 million building program at Texas City, Texas, which included a new administration building and enlarged engineering and research laboratories, "because of conditions in the oil industry."

Cities Service Oil's $18 million expansion program at Chicago is well along. The $3 million delayed coker is on trial runs, the Fluid unit began test-runs in late March. Most of the auxiliary units, including boiler house enlargement, more electric power generation and new water supply, are in operation.

The first cracking furnace of the Petrochemicals Ltd. plant, near Manchester, England, employing the Catarole process, has gone on stream and throughput is claimed to be above rated capacity. The process, an English invention, converts a petroleum distillate into liquids and gases which are subsequently processed in other plants to yield a variety of chemical raw materials formerly either imported or produced from coal tars. The gas yield is blended with the community gas supply.

Shell Oil of Canada to increase crude throughput to 27,000 b/d at its Montreal plant, adding catalytic cracking, vacuum flashing and increasing gas polymerization, gas recovery and treating facilities. Arthur G. McKee & Co., Cleveland, and Fluor Corp. of Canada, contractors.

The Texas Co. is adding 9000 Mcf. per day to gas processing capacity at its Magnet-Withers compressor plant near El Campo, Texas, by installing three 600 Hp. compressors. Tellepsen, Houston, contractor.

Panhandle Producing Co. is installing an automatic Desulfo plant near Stinnett, Texas, to remove excess hydrogen sulfide (with an ethanolamine solution) from a potential 2750 Mcf. daily of natural gas. Stacey-Dresser Engineering, Cleveland, contractor.

• • •

FROM THE ANNUAL REPORTS

Capital expenditures of Continental Oil Co. in 1948 were $51,300,000 and exceeded by $17,700,000 the amount of cash retained from operations through current charges against earnings for depreciation, depletion, intangible developmnt costs, and property retirements.

Phillips Petroleum Co.'s capital expenditures in 1948 were $138,968,629, of which 48.4% was distributed to crude oil investments and 31.6% to manufacturing. In 1949 capital expenditures of approximately $50,000,000 will be made for crude oil activities and $60,000,000 for diversified projects, largely refining and chemical manufacturing, which will start producing income this year.

Replacements and expansion of facilities involving expenditures of $100,000,000 are planned by Standard Oil Co. (Ohio) for 1948, '49 and '50. Expenditures in 1948 amounted to $27,772,145.

Capital expenditures of The Texas Co. in 1948 were $235,000,000 and estimated expenditures for 1949 are $275,000,000. This total of $510,000,000 will exceed charges for depreciation, depletion and amortization during the two-year period by approximately $365,000,000.

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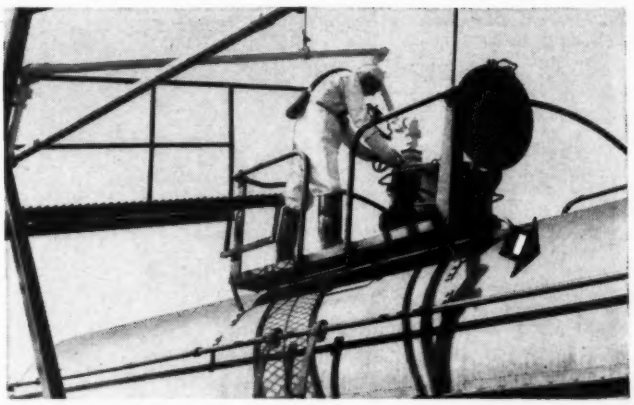
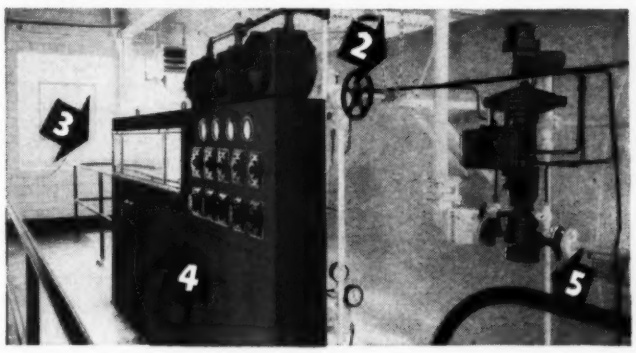
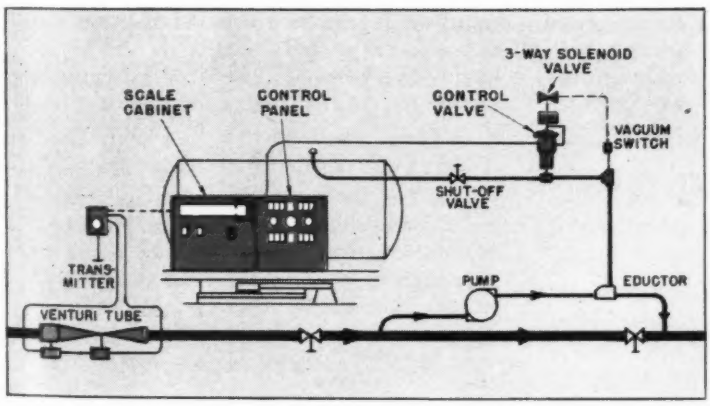


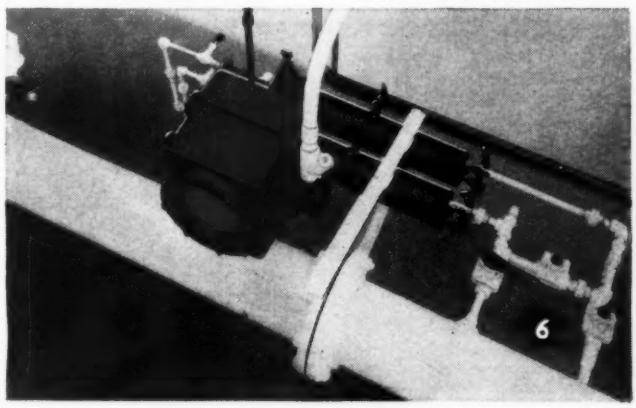
1–T.E.L. Fluid is drawn under vacuum from tank car.



2–Fluid storage tank on standard scale. 3–%Proportioneers, Inc.% Automatic and Flow Responsive Loss-In-Weight Proportioning Scales. 4–Complete alarm panel fully protects system. 5–Specially designed Diaphragm Control Valve for T.E.L. Fluid.



All equipment shown red in photos and flowgram furnished by %Proportioneers, Inc.%



6–Venturi Meter measures gasoline flow through pipeline and maintains uniform pre-set lead treatment.

No. 2 in a series on T.E.L. blending.

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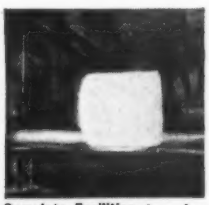

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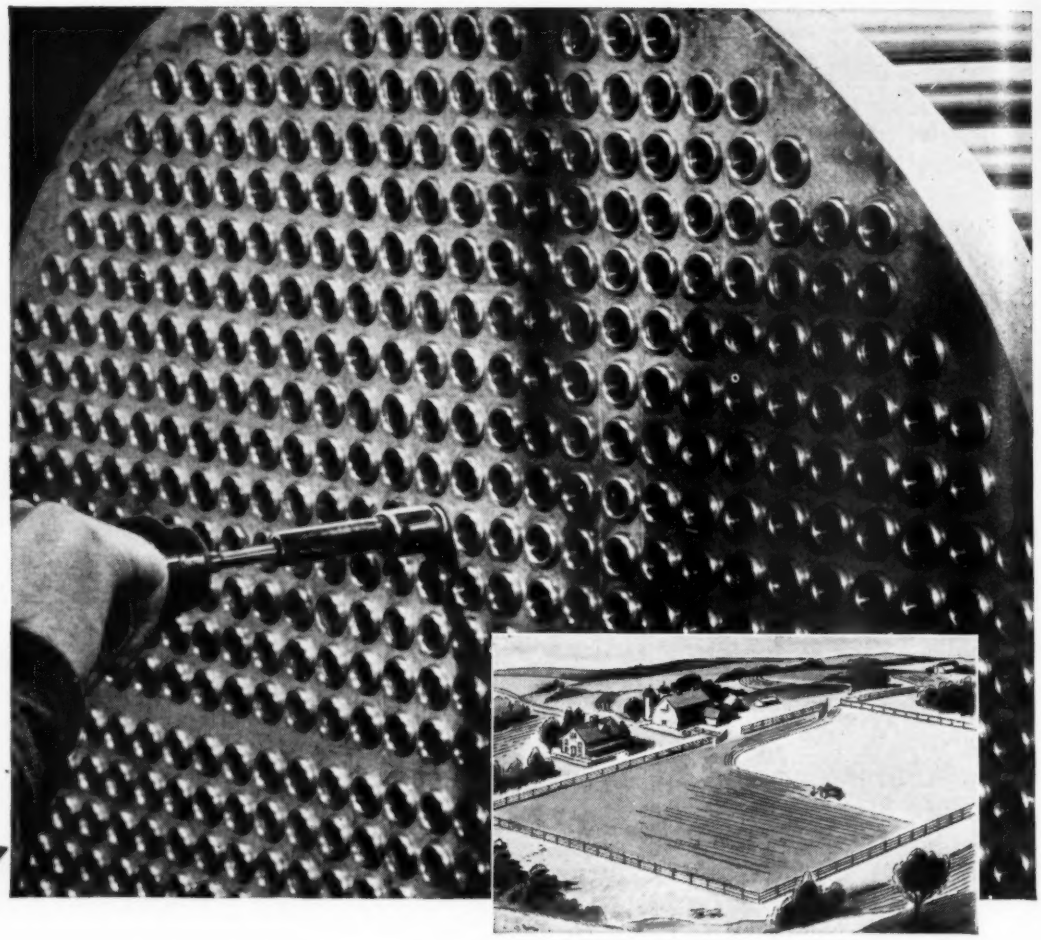

When an acre is small potatoes

ONE ACRE—43,560 square feet. It sounds like a lot of surface when talking about mowing a lawn. But it's "small potatoes" when you consider a recent Kellogg order for a quarter million square feet of heat exchanger surface—more than five acres. Another on the books for better than 200,000 square feet and yet another for 190,000 square feet.

That acre isn't so impressive now. But don't just consider the size of these orders. Think what orders of this magnitude imply.

Any group of heat exchangers for a normal refinery reaching such total transfer area would of necessity include all types for all refinery uses. Thus specialization as to size or application can't be the reason why Kellogg gets these tremendous orders. Price could be a determining factor but here again the modern refiner knows that the real economy in heat exchangers is found in high performance and low maintenance.

No, it is a lot more basic than price or type specialization. We like to believe that these orders result from two things: The acceptance of The M. W. Kellogg Company as outstanding in the technical advancement of the science of heat exchange itself, and twenty-five years of experience in manufacturing techniques that give Kellogg heat exchangers an appreciable advantage in lower maintenance cost.

It is the continuing research into better methods of transferring heat and the continuous development of better manufacturing techniques that creates this overall acceptance of M. W. Kellogg products.

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Tomorrow

. . . IN PETROLEUM TECHNOLOGY

Brief reviews of currently reported technological and economic developments, in the light of their potential bearing on petroleum refining

All Types of Fuels Respond To Anti-Detonant Injection

DISCUSSION BECOMES MORE FREQUENT on the subject of securing higher octane performance from current motor gasolines by use of a special high compression fuel only during the period of engine operation when high octane requirement is needed. A report on test work with the Thompson Vita-Meter anti-detonant device stated that the investigations involved the use of straight-run gasoline only with the anti-detonant fluid, an alcohol-water-TEL solution.(1) The point was made that such test work should include the use of cracked gasolines, since these were the types of fuel being supplied to the public in largest volume.

However, it should be brought out that extensive investigations being carried on by the Fuels and Lubricants Service Division of Standard Oil Co. (Ohio) of the use of anti-detonant injection in high compression engines have included various types of fuels. Composition fuels individually aromatic, naphthenic, paraffinic and olefinic in type were used in one set of tests with the Vita-Meter, as well as a typical commercial premium grade gasoline.(2)

R. I. Potter, chief of Sohio's Fuels and Lubricants Service Division, reported that basic fuels of the four types can be extended to essentially 100-octane or higher by means of anti-detonant injection. The amount of the anti-detonant fluid added, it was found, depended upon the base octane number and the chemical composition of the fuel. Road octane number of the premium gasoline was increased, with injection, over a range of 4 to 9.5 numbers, depending on the engine speed.

"Since most regular and premium gasolines today are composed of a combination of these four chemically classified fuels (aromatic, naphthenic, paraffinic and olefinic) and are not usually any one pure hydrocarbon type," it was stated, "anti-detonant injection can be expected to add needed octane numbers to any combination of hydrocarbons found in the anti-knock range of premium gasolines".

An interesting feature of Sohio's work in this field is the development of a 9 to 1 compression ratio test engine from a six-cylinder stock model, for use both in laboratory work and road tests. The combustion chamber volume required to produce an engine in the range of 9 to 1 compression ratio was found to be about 73 cc's, and this was achieved by changing the piston design of the stock engine. It was found that an improved type distributor, spark plugs, ignition coil and carburetor would add considerably to the smooth functioning and performance of the engine when placed in the chassis. The report states:

"It appears that this laboratory test engine is quite normal in its power response to compression ratio increase, and can be expected to give other test results comparable with possible future 9 to 1 compression ratio engines".

High Quality Fuels Refined From Oil Retorted from Shale

A REFINING TECHNIQUE by which 85% of oil retorted from shale can be refined into high quality fuel, stove oil and diesel fuel, as reported by Union Oil Co. of California,(3) may advance materially the commercial development of this source of synthetic liquid fuels.

Part of the sulfur and nitrogen compounds which exist in the shales are recovered during the extraction operation and are present in the raw shale oil. The difficulties inherent in removing these substances during the refining step heretofore have been considered a major obstacle to the economic utilization of our western shales as sources for liquid fuels.

"Currently it appears that a combination of preliminary coking with mild hydrogenation by the Cobalt-Molybdate process will effectively remove the nitrogen, sulfur and oxygen-containing constituents from shale oil", it is stated. "By this operation approximately 85% of the shale oil can be refined into high quality fuels".

Shale oil from retorting Colorado shale is characterized by a high degree of unsaturation, high pour point and contamination with compounds containing oxygen, nitrogen and sulfur. A typical ultimate analysis of oil from 30-gal. per ton shale is reported as follows:

	Wt. %
Carbon	84.9
Hydrogen	12.1
Sulfur	0.8
Nitrogen	1.9
Oxygen	0.3

"With proper visbreaking or coking to reduce pour point, shale oil may be used for fuel oil", it is said. "However, for use in automotive or diesel engines, shale oil requires extensive refining to remove the contaminating compounds of oxygen, nitrogen and sulfur. The hydrogen-carbon ratio of shale oil approaches that of average California crude.

"However, appreciable quantities of hydrogen are required to eliminate the unsaturation as well as the contaminating compounds."

The sequence of thermal coking, followed by catalytic hydrogenation is reported as the best refining operation under today's economic conditions. Hydrogen requirements are about 1000 cu. ft. per bbl. of coker distillate. Sulfur and nitrogen are completely eliminated from the refined products. Yields by the coking-hydrogenation technique from 100,000 bbls. of crude shale oil included 51,500 bbls. of stove oil of 51° API gravity, −70°F. freezing point, and 0.05 max. wt.% sulfur; 33,500 bbls. of diesel fuel of 37° API gravity, 0.02 wt.% sulfur, 59 Cetane number, 25° F. pour point and 39 vis. at 100° F; 2380 tons of coke and 260 tons of ammonia. Gas, including C_4's and C_5's, amounted to 51,000 MSCF.

Another important contribution of Union Oil Co. in the development work on shale oil has been an entirely new type of retort, employing a kiln with a bottom feed of solids and countercurrent flow of shale and air. Ash and clinkers are removed overhead and the oil drains out the bottom. The oil is distilled by a downward flow of heat furnished by the combustion of the residual carbon on the shake clinker at the top of the kiln. The design of the unit is such that almost perfect heat exchange is obtained, it is said.(4)

It is significant that these two

(1) Anon., PETROLEUM PROCESSING, Jan. 1949, pg. 104.

(2) R. I. Potter, "Use of Anti-Detonant Injection in a High Compression Ratio Engine," presented before SAE Summer Meeting, French Lick, Ind., June 6-11, 1948.

(3) Homer Reed, Clyde Berg, Hugh Multer, Union Oil Co. of California; "Retorting and Refining of Oil Shale," presented before Colorado Mining Assn., Denver, Jan. 31, 1949.

(4) Homer Reed, Clyde Berg, Union Oil Co. of California; "Shale and Air Counter-Flow in New Continuous Retort," PETROLEUM PROCESSING, Dec., 1948, pg. 1187.

important developments come from an oil company's research laboratories, since the maximum publicity for work in the Synthetic Fuels Research program has gone to the Bureau of Mines.

Improved Production Processes For Butadiene from Alcohol

DURING THE RECENT WAR, alcohol was used in large quantities for the production of butadiene, giving way to petroleum processes for butadiene production only when the huge plants needed had been completed, when adequate C_4 hydrocarbon stocks became available, and when the end of the war signalled the end of the need for the use of uneconomic processes. Since that time, "butadiene from alcohol" has been a subject largely for the agricultural politician, who wants to see farm products used regardless of cost, and for the technical economists who, looking ahead to the future of ethyl alcohol production from petroleum and (via the Synthine process) from natural gas, were sometimes of the opinion that the cost of ethyl alcohol might eventually fall to the point where butadiene production therefrom might actually become economic.

It must be remembered, in this regard, that the American process for the production of butadiene from ethyl alcohol was developed by the Carbide and Chemicals Corporation, one of the leading producers of chemicals from petroleum and at that time the only producer of ethyl alcohol from petroleum materials. In developing its process, one cannot guess that Carbide expected butadiene to come into such large demand and, more or less consequently, that processes using less expensive raw materials would take away the market, but the fact remains that a technically sound, commercially proved process was developed and that its present nonuse is a matter of economics; moreover, that plants capable of using it are in existence in a standby capacity.

Whether Carbide and others have continued research on this process in recent years has not been revealed, but it is more than interesting to note that work performed at the Mellon Institute by the fellowship sponsored there by the RFC's Office of Rubber Reserve indicates that the full potentialities of the process have not been realized. The work in question was terminated sometime in 1947, "because of a change in the program," but preliminary results of the study showed that it was possible to obtain higher butadiene yields by two different methods.

Both of these deal with the second step in the two-step process developed by Carbide and Carbon. In the first step, ethyl alcohol is converted to acetaldehyde in a 92% yield by a well-developed process; in the second step; however, in which ethyl alcohol is reacted with the acetaldehyde, yields were such that "the best overall yield of butadiene from the two steps was 65% of the theoretical."(5)

"It has been demonstrated that injecting an auxiliary side stream, rich in acetaldehyde, into the catalyst bed at or above the midsection, where the aldehyde is rapidly depleted, leads to yields of 64 to 68 mole % and conversons of 35 to 37 mole % per pass. These results compare with 63 and 34 mole %, respectively, for calibration runs without the side stream. An increased total throughput, hence increased production, is also realized.

"The second novel method of operation comprises an auxiliary feed of ethyl alcohol added at or below the midpoint of the catalyst section; this affords consistent yields of about 76 mole %. Preliminary work on a two-step process with ethyl alcohol-acetaldehyde feeds has been found promising, but further study is required. Carbon deposition is not prohibitive in these procedures."

All such work has been pointed up considerably by the recent drastic change in the market price of ethyl alcohol. As recently as last November, this commodity was selling for about 70 cents per gallon on the open market; early in March, the price was 17-20 cents per gallon. Several reasons for this drop have been advanced, the chief of which are: (1) the year-end appearance on the open market of the output of Shell's new petroleum alcohol plant (reported capacity, at least 20,000,000 gallons per year) and (2) the concurrent purchase of the 80,000,000-gallon remainder of Cuba's 1948 "molasses crop" by Publicker Industries, Inc., at a special price, followed by a rapid weakening in the whole molasses alcohol price structure.(6)

There is no great likelihood that the price of ethyl alcohol will fall in the immediate future to the level necessary to make butadiene production profitable, nor is there necessarily any real prospect that enough low-cost alcohol would even then be available to permit large-scale butadiene production. However, the internal price calculations of such companies as Carbide and Carbon, which already consumes practically all of its alcohol production in further chemical synthesis, are such that there is no certainty exactly when and if it will be decided that butadiene production from alcohol will be desirable. The advent of "cold rubber" seems to have assured a large-volume market for butadiene; this, coupled with the changing economics of ethyl alcohol production, will make the situation worthy of continued attention.

(5) P. M. Kampmeyer and E. E. Stahly, "Butadiene from Alcohol; Improved Production Processes," *Industrial and Engineering Chemistry* 41, No. 3, 550-55 (1949).

(6) Anon., "Alcohol Drops, Cuba Suffers," *Business Week*, No. 1018, 106 (1949).

Reclaimed Synthetic Rubber Proves Satisfactory

DURING THE EARLY YEARS of the recent war, consternation reigned in all quarters of the rubber reclaiming industry, faced with the seemingly hopeless (or at least entirely new) task of segregating synthetic rubber and part synthetic rubber scrap from natural rubber scrap and developing methods of reclaiming all such scrap materials. Moreover, little was known as to the properties of reclaimed synthetic rubbers, particularly the GR-S varieties, and there was a rumor current that such reclaimed "rubber" was inferior to reclaimed natural rubber, a product itself quite inferior to "new" rubber in many properties but highly useful and economic in various admixtures with it.

Time and the application of good scientific elbow grease have quieted the worst fears on almost every score. The reclaimed rubber industry has practiced scrap segregation wherever possible; it has developed expedient tests to determine the composition of unknown scrap materials; it has developed various new reclaiming methods and variations of the old method for natural rubber reclaiming (alkali digestion); and it has proved by tests that reclaimed GR-S is actually superior to reclaimed natural rubber in such applications as use in tire tread compositions (in admixture with new GR-S or natural rubber).

The literature on this subject has already grown weighty, so the appearance of a good, recent review(7) has served to bring this picture into sharper focus. The significance of quality reclaimed synthetic rubber is several-fold. First of all, its existence means that the normal economic balance in the rubber industry between the use of the higher priced (but higher quality) new "rubber" and the lower priced (but still quite useful) reclaimed "rubber" will not be disturbed. This, in turn, has meant that the production of synthetic rubber can proceed without regard to side factors regarding scrap and that competition with natural rubber can be conducted on the normal basis of initial quality and price.

Scrap materials play an important role in the modern economic picture, as witnessed by the scrap iron, rubber, rags, and waste paper industries.

(7) F. L. Kilbourne, Jr., "Reclaiming Synthetic Rubber," *Rubber Age* 64, No. 5, 581-89 (1949).

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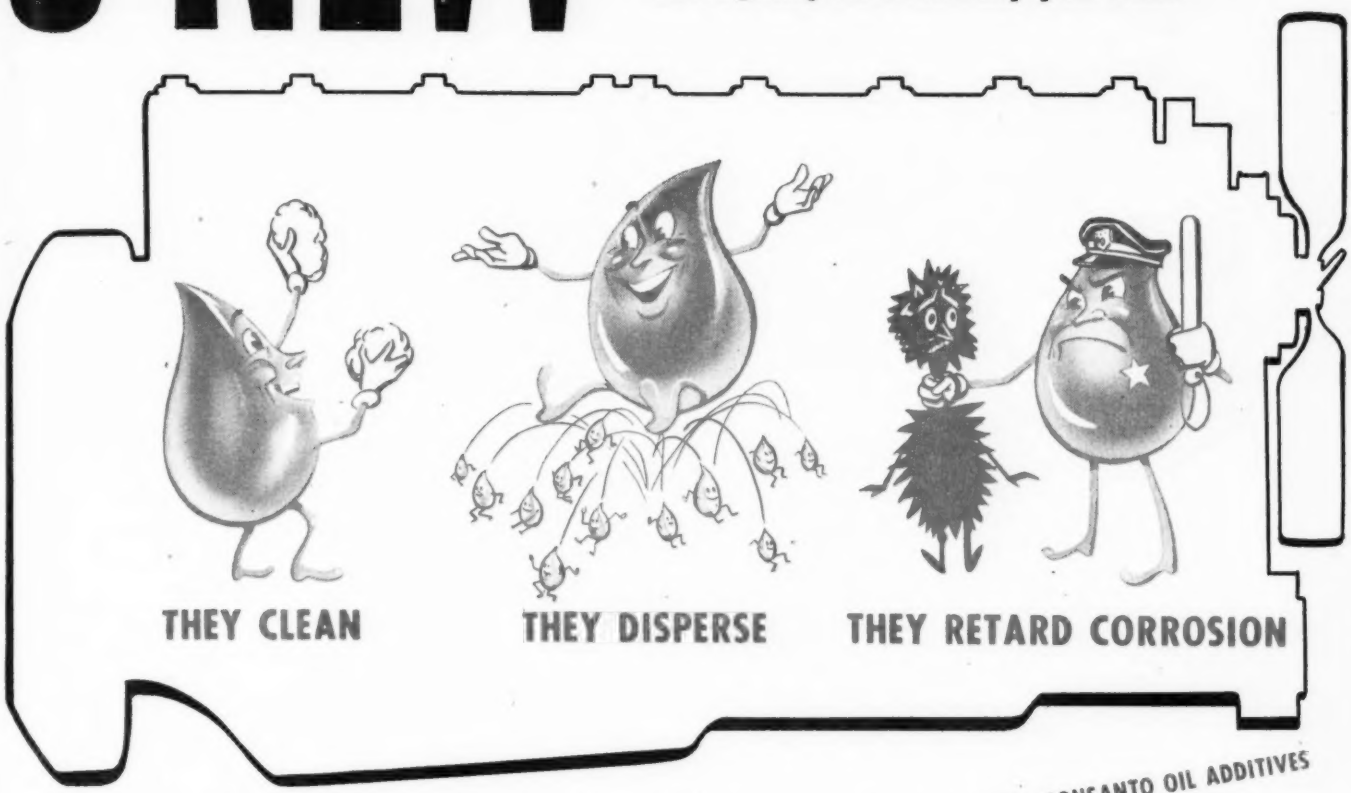

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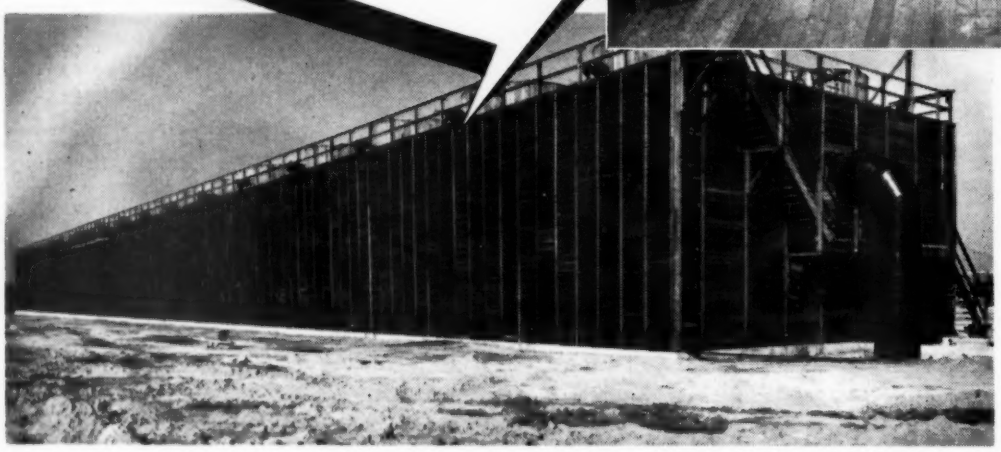

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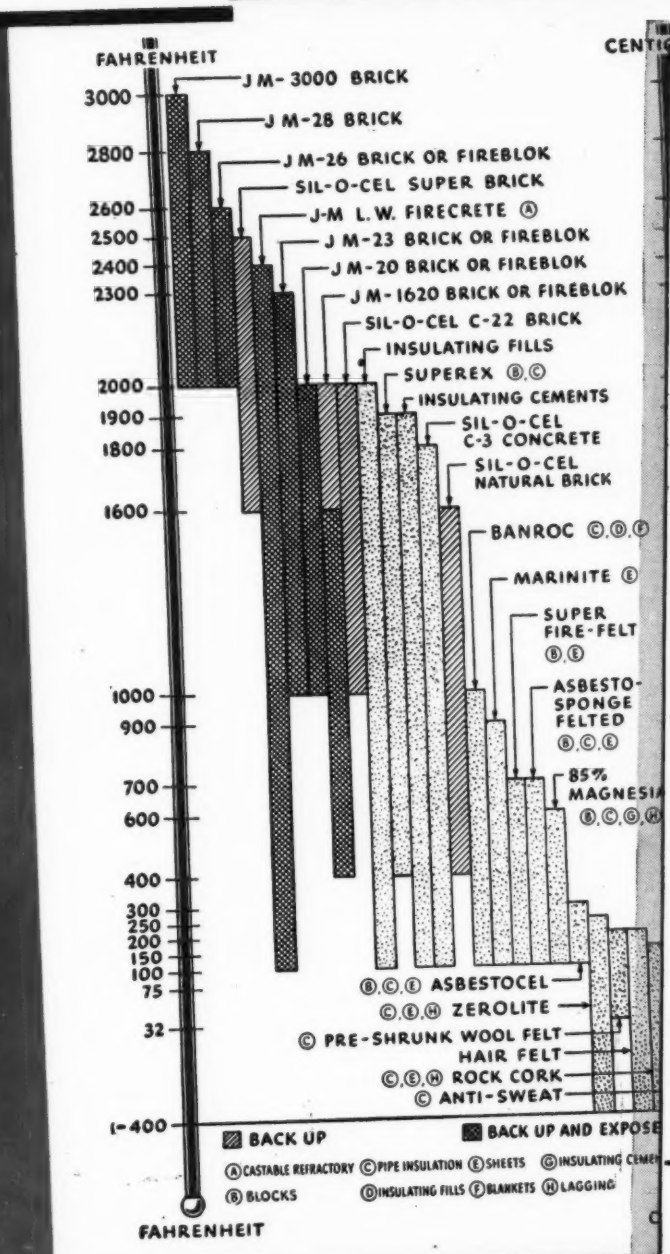

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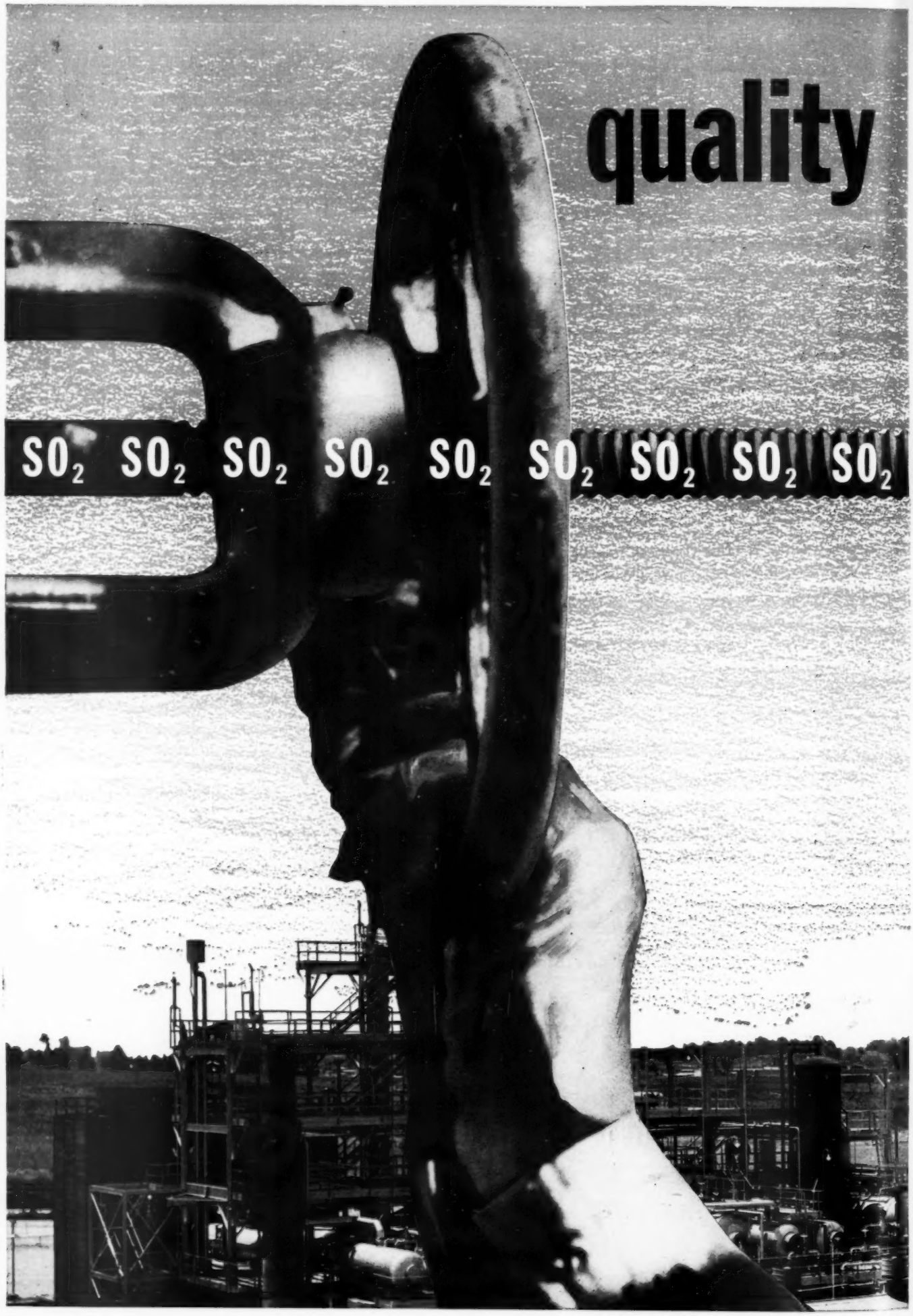
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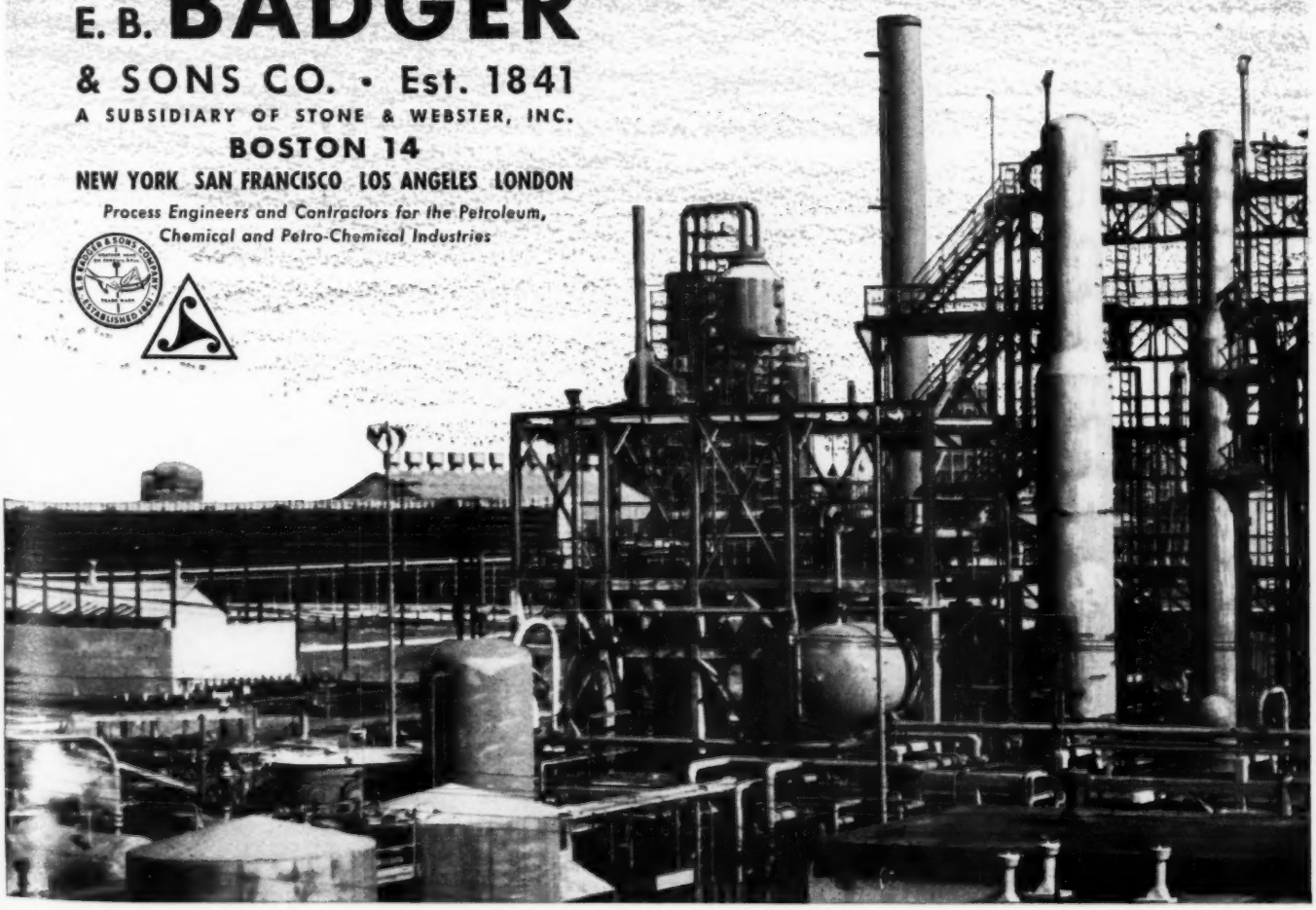

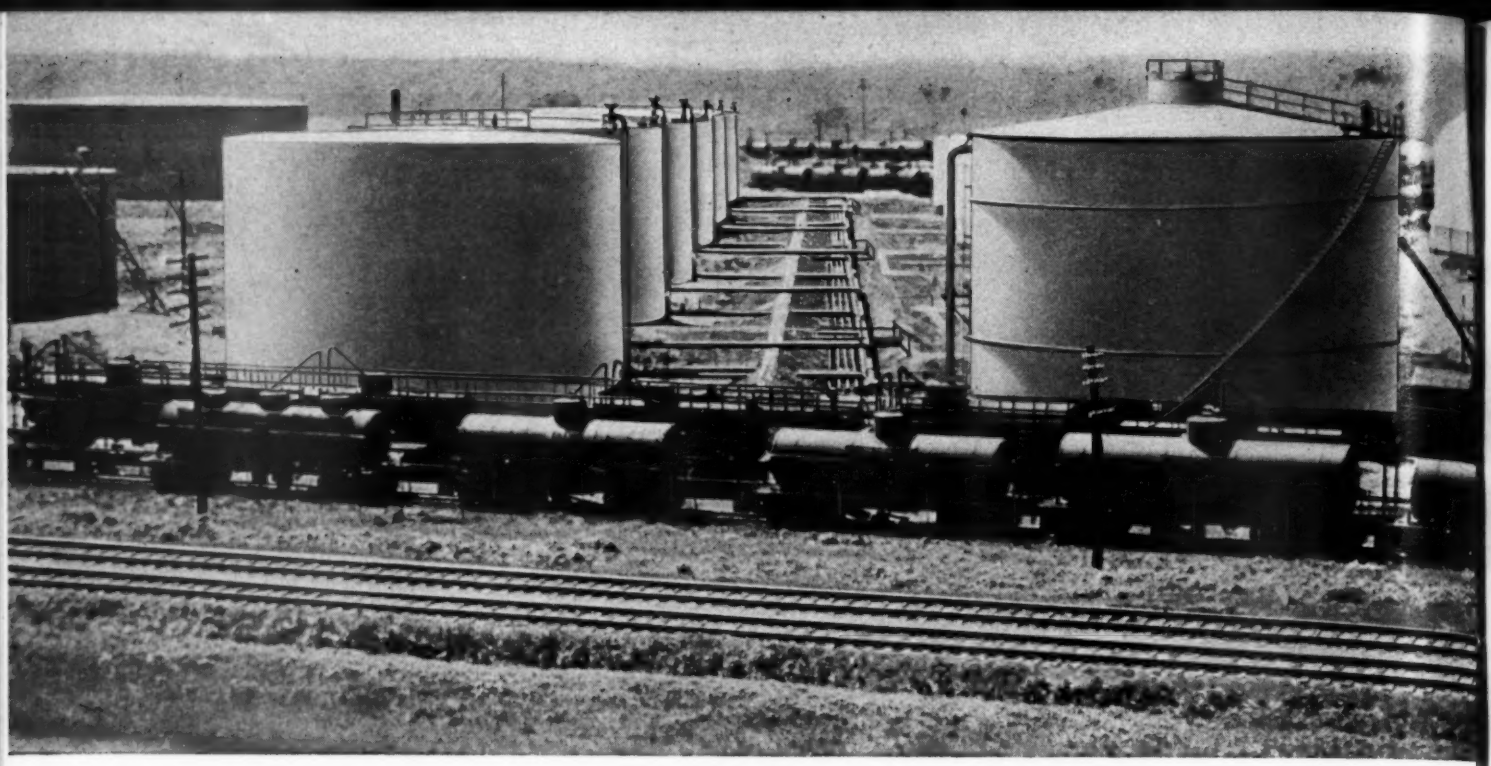

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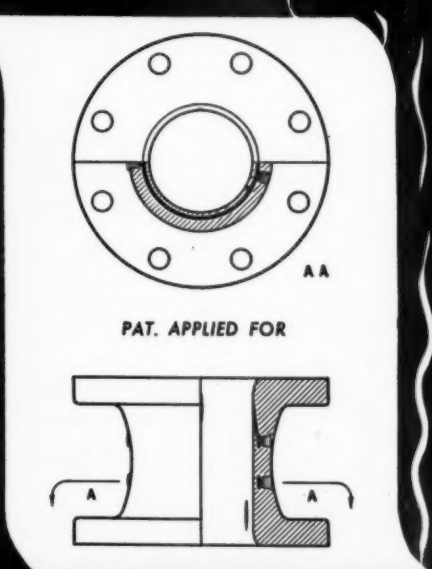

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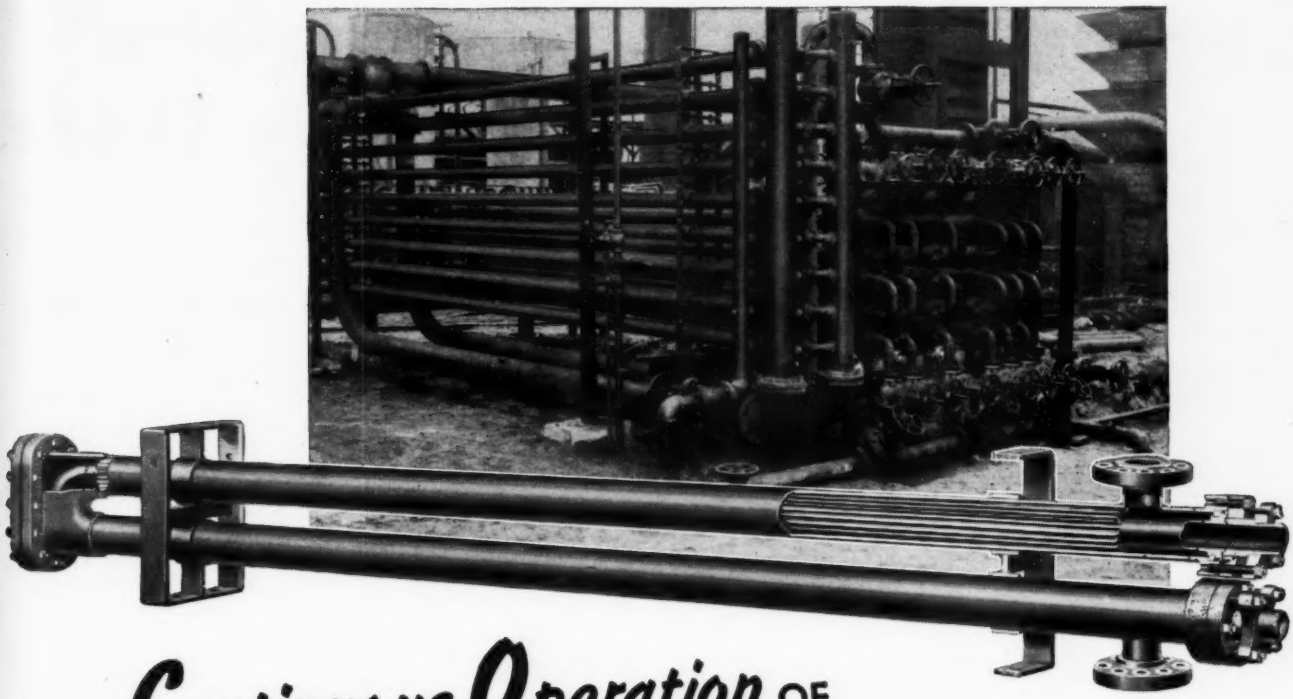

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4. Easy Inspection and Maintenance
5. Continuous Operation. No Shut Downs for Servicing.
6. Minimum Investment in Replacement Parts.
7. The Brown Resistance Welded Integrally Bonded Fintube.
8. Easily Removed Rear End Cover Plate.

Write today for Bulletin No. 481. It gives full details

PAYS USERS EXTRA DIVIDENDS

● When they're "on line"—heat exchangers are making money with which to pay wages, bonuses, salaries, dividends. When they're down for servicing,—money is going out—not in.

A bank of Brown Fintube Sectional Hairpin Heat Exchangers can be kept in continuous service—on dirty duty—at high efficiency. The bank doesn't have to come off line for servicing. Users simply manifold an extra parallel stream into the bank. Then they can clean, and make whatever repairs are necessary, to first one stream, then another, while the bank is carrying its full rated load, continuously, at a profit. Simple, isn't it?

Let us help you in adapting Brown Fintube Sectional Hairpin Heat Exchangers—with their many outstanding operating and maintenance advantages—to your next heat transfer requirement. The Brown Fintube Company, Elyria, Ohio. Sales engineers in the principal cities.

BROWN FINTUBE
Sectional Hairpin
HEAT EXCHANGERS

RESISTANCE WELDED INTEGRALLY BONDED FINTUBES AND FINTUBE HEAT TRANSFER PRODUCTS

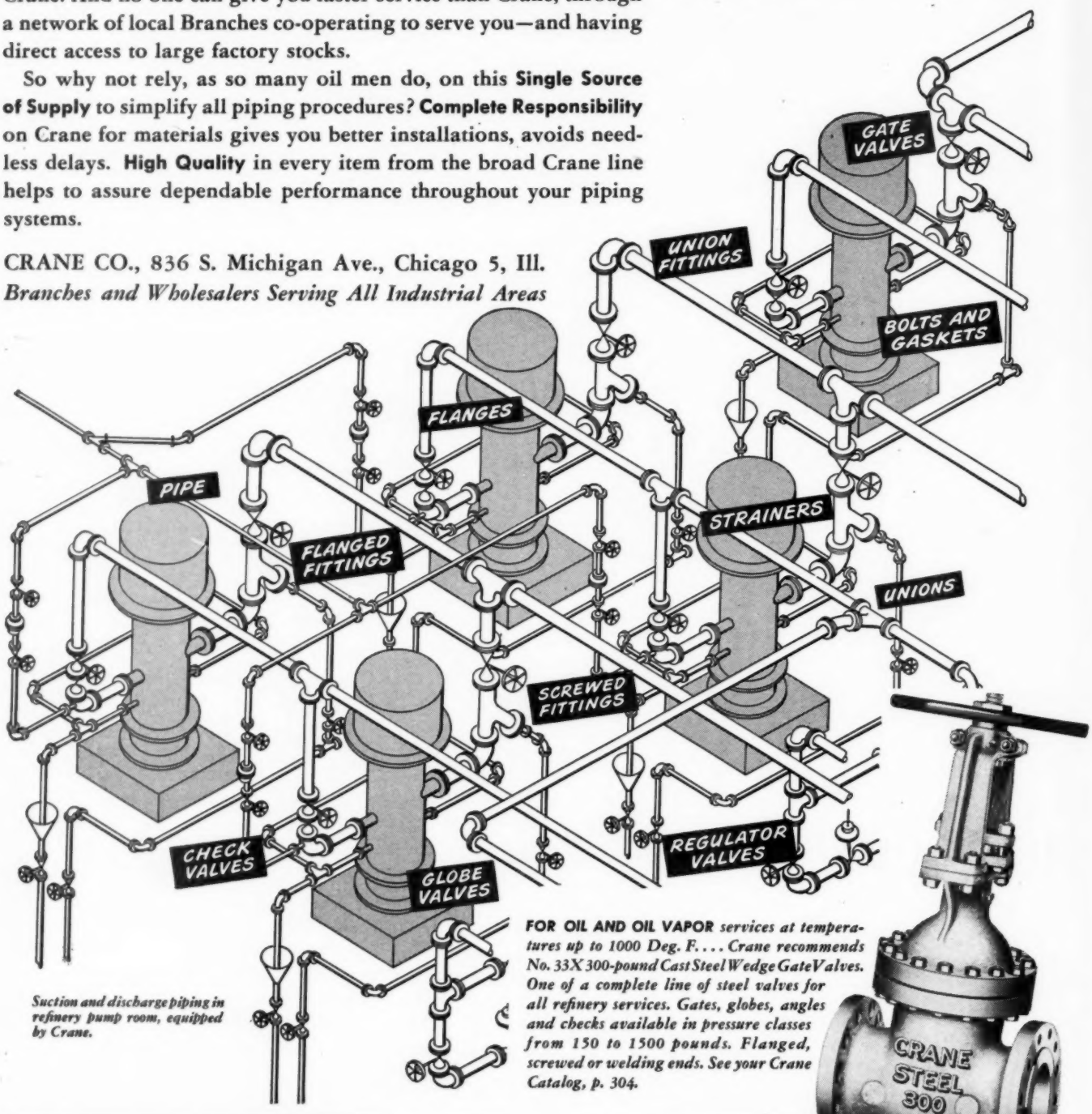
Complete selection in refinery piping ... on one order to CRANE

It's good to remember that Crane can supply all refinery piping needs on one order. A good example is this **Suction and Discharge Piping**—all valves, fittings, pipe and accessories are available from Crane. And no one can give you faster service than Crane, through a network of local Branches co-operating to serve you—and having direct access to large factory stocks.

So why not rely, as so many oil men do, on this **Single Source of Supply** to simplify all piping procedures? **Complete Responsibility** on Crane for materials gives you better installations, avoids needless delays. **High Quality** in every item from the broad Crane line helps to assure dependable performance throughout your piping systems.

ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



Suction and discharge piping in refinery pump room, equipped by Crane.

FOR OIL AND OIL VAPOR *services at temperatures up to 1000 Deg. F.... Crane recommends No. 33X 300-pound Cast Steel Wedge Gate Valves. One of a complete line of steel valves for all refinery services. Gates, globes, angles and checks available in pressure classes from 150 to 1500 pounds. Flanged, screwed or welding ends. See your Crane Catalog, p. 304.*

EVERYTHING FROM ...

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

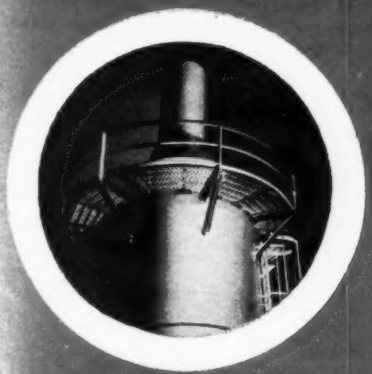
CRANE

FOR EVERY PIPING SYSTEM

PETRO-CHEM ISO-FLOW CATALYTIC REACTOR FURNACES WITH . . . CATALYST IN TUBES

CATALYST TUBE FURNACES, to operate successfully, require accurate heating with controlled variations in the heat intensity, depending upon the charging stock chemical reactions, type of catalyst and the end product desired.

With Petro-Chem design, the heat intensity may be varied at different elevations to give a wide range of accurately controlled flexibility required for catalytic reactions. Vertical tubes simplify the handling of the catalyst.



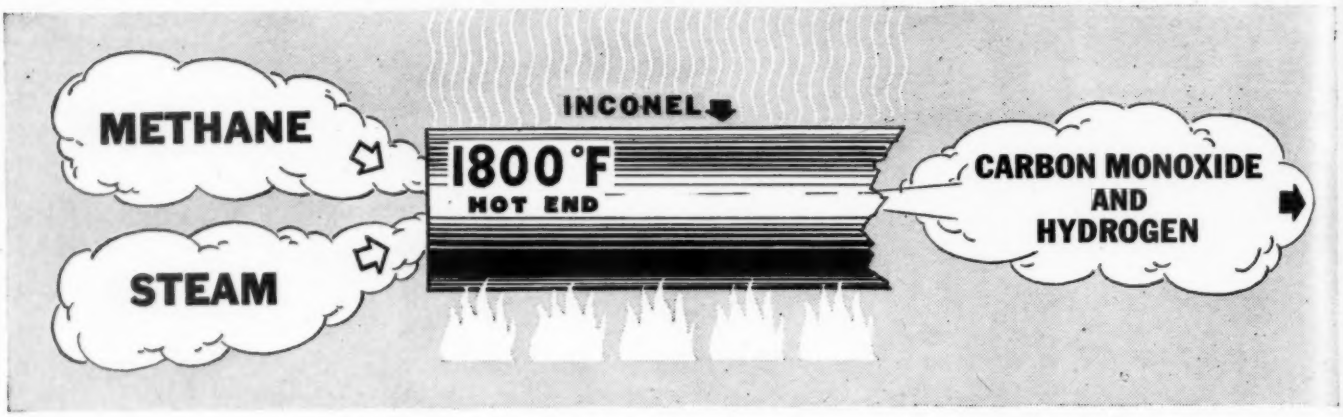
PETRO-CHEM

ISO-FLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

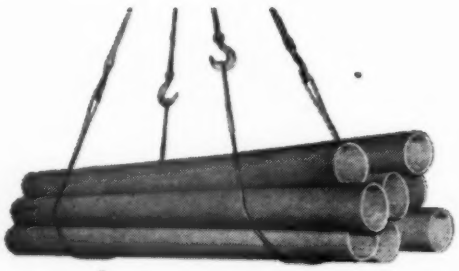
PETRO-CHEM DEVELOPMENT CO., INC.
120 EAST 41ST STREET, NEW YORK 17, N. Y.

Representatives: Bethlehem Supply Co., Tulsa and Houston • Lester Oberholtz, Calif. • D. D. Foster Co., Pittsburgh • Faville-Levally Corp., Chicago



Hydrocarbon Synthesis—FROM METHANE AND STEAM

WILL INCONEL BE THE ANSWER TO THE HIGH TEMPERATURE PROBLEM?



LARGE DIAMETER EXTRUDED INCONEL TUBING IN VARIOUS SIZES!

You can order extruded Inconel tubing in outside diameters from 2½" to 9¼"; wall thicknesses from ¼" to ⅝". Length varies according to diameter; ranges from 6' to 22'. For closer tolerances and thinner walls, sizes up to 4½" O.D. are produced by cold drawing. Write for complete information.

Inconel* is rightly regarded as one of the outstanding metals for resistance to high temperatures.

Now the questions are being asked: *Is Inconel the answer to the hot-end of hydrocarbon synthesis? Will Inconel have a service life measured in years rather than hours?*

Already On Trial

Nobody can say—but at least one manufacturer is using Inconel tubing for experiments in fuel synthesis from methane and steam. In this particular case, the components enter the synthesizer hot-end at a temperature close to 1800° F., passing through an Inconel tube that is heated on the outside by the combustion of methane. Inside surfaces of the tube operate continuously under carburizing conditions; the outside is exposed to severe oxidizing conditions.

Inconel was chosen because of its proved hot-strength and resistance to creep and carburization.

Other High Temperature Service

Inconel has been used successfully by heat treaters in both strongly oxidizing and reducing conditions...at temperatures up to 2000°F. Inconel fixtures serving over two years are still in excellent operating condition.

REMEMBER *Inconel when you're looking for materials to resist carburization and oxidation at high temperatures in hydrocarbon synthesis. Turn some of your problems over to our Technical Service. These men know what has been done (and what is being done) to provide durable metals for your kind of work.*

EMBLEM OF SERVICE
INCO
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Inconel*—FOR LONG LIFE AT HIGH TEMPERATURES

*Reg. U. S. Pat. Off.

DESIGNERS and MANUFACTURERS! Sand|castings|and precision castings of Monel*, Nickel, Inconel* and other Nickel alloys are available from Inco's own foundry, backed by a half century of experience with Nickel and Nickel Alloys.

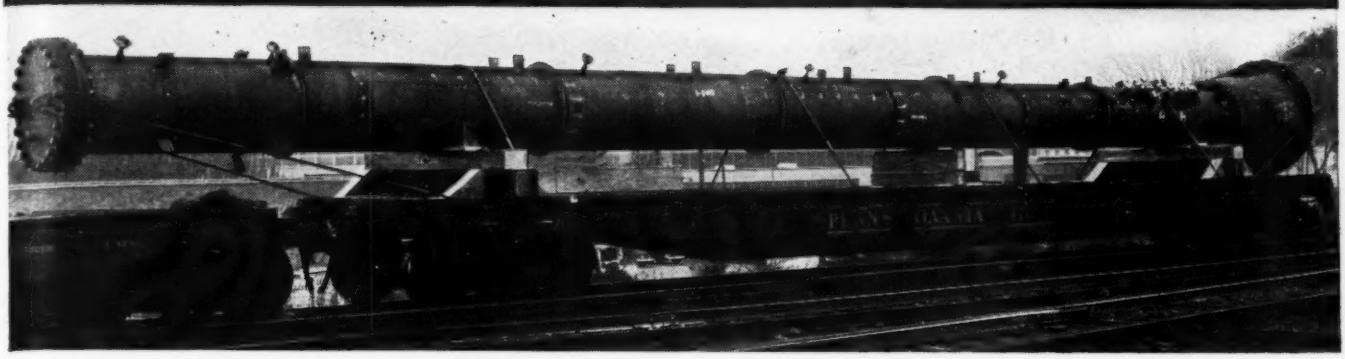
VESSEL DIVISION

NEWS

A. O. Smith 75th ANNIVERSARY 1874 - 1949

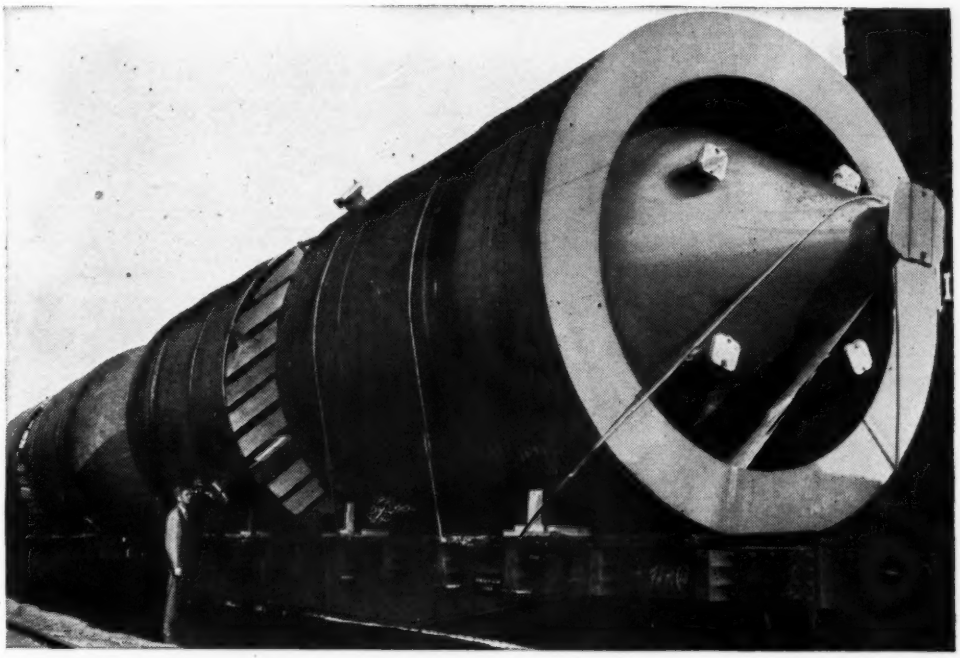
A. O. SMITH Corporation

New York 17 • Philadelphia 5 • Pittsburgh 19 • Atlanta 3 • Chicago 4
Tulsa 3 • Dallas 1 • Houston 2 • Seattle 1 • Los Angeles 14
International Division: Milwaukee 1

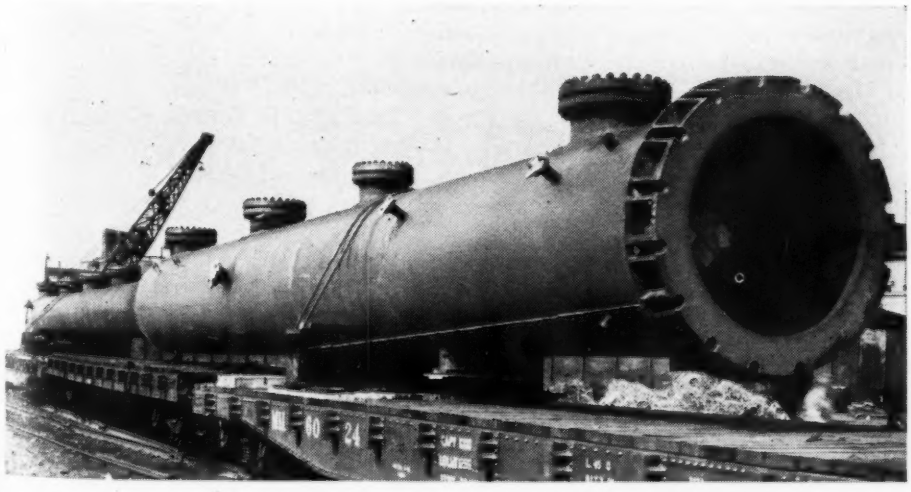


INTO EVERY SMITHlined FAT-SPLITTING TOWER, like the above 68-ft.-long SMITHway Tower, goes the experience and knowledge gained from a long and extensive program of research and development into the corrosion problems of the Fatty Acid Industry.

THREADING A NEEDLE. Getting a 12 ft. dia. by 43 ft. long paper mill replacement digester into an existing building is a difficult feat. A. O. Smith did it by shipping the SMITHlined Digesters *in sections* for final assembly and welding in place inside the paper mill.



A. O. SMITH MAKES ALL TYPES OF OIL-REFINING PRESSURE VESSELS. Here is one type, a SMITHlined Absorber Tower three railroad cars long (approximately 107 ft. long), leaving for a refinery in Ohio.



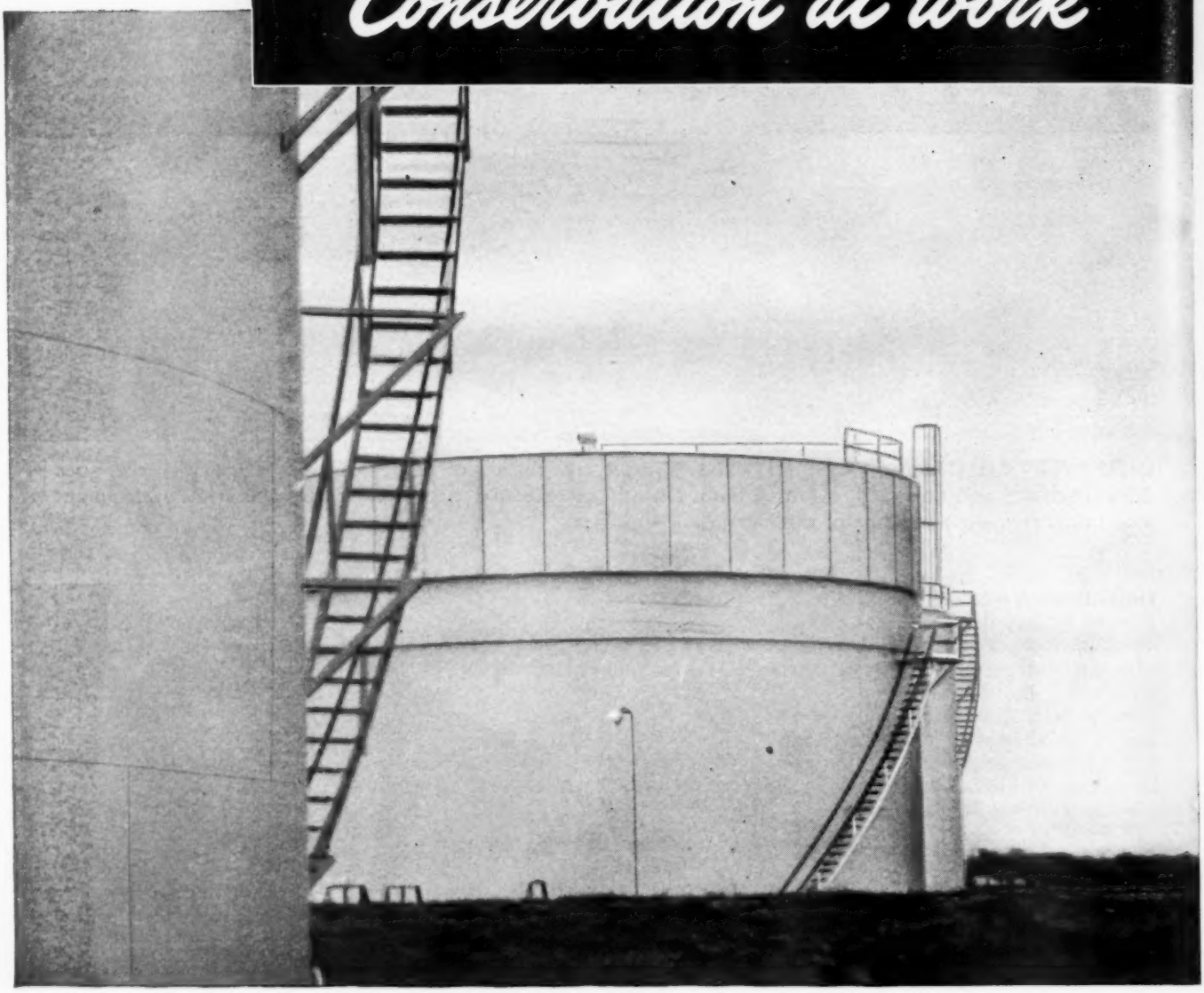
NEW BULLETINS

Write the nearest A. O. Smith office listed at the top of this page for these new A. O. Smith Bulletins:

FIELD ASSEMBLY OF PRESSURE VESSELS — Bulletin V-44.

SMITHway VESSELS, Alloy, Alloy-Lined, Clad, and Glass-Lined—Bulletin V-46.

Conservation at work



THE EXPANSION ROOF STOPS VAPOR LOSSES

Elimination of vapor losses . . . conservation through the use of Expansion Roof Tanks . . . has proved its value to producers, refiners and marketers alike, both in preventing the loss of salable product and in maintaining octane rating.

The Expansion Roof permits no venting to the atmosphere and no intake of moisture laden air. Instead, it rises to accommodate expanding vapors, lowers as the pressure decreases. Perfectly suited to either single or multiple tank installations (through manifolding) the Expansion Roof results in direct dollar savings wherever petroleum products are stored.

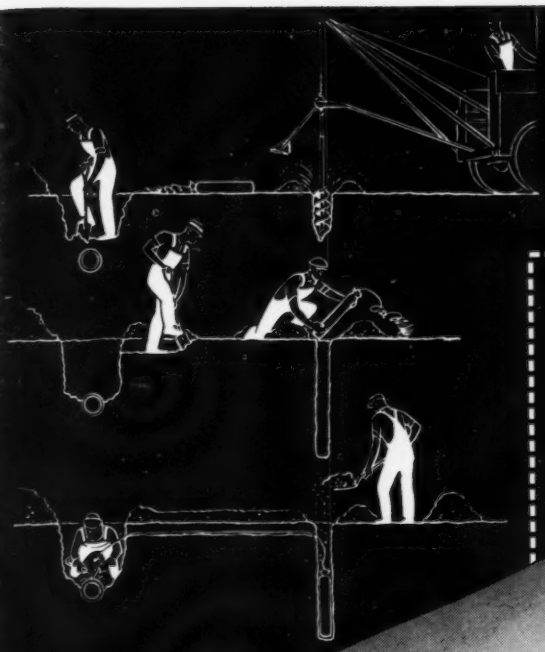
Call Graver today. Find out just what the installation of Graver conservation equipment will mean to you in terms of marketable product saved.

FABRICATED PLATE DIVISION

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

NEW YORK PHILADELPHIA CHICAGO CATASAUQUA, PA.
HOUSTON SAND SPRINGS, OKLA.



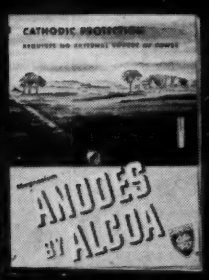
install for little

maintain for less

Your pipe lines gain effective corrosion protection for low installation cost with a simple system of Alcoa Magnesium Anodes. In three quick steps, your field crews uncover the line, install and attach the anode, backfill and cover.

Alcoa anode systems require no external power source. They never get out of order or need repairs. Maintenance is practically nil for their entire life.

Ask your nearby Alcoa sales office for copies of booklets to help explain Alcoa cathodic protection to all interested members of your organization. Or write to ALUMINUM COMPANY OF AMERICA, 626 Gulf Bldg, Pittsburgh 19, Pa.



FREE BOOKLET tells the simple story of Alcoa Pipe-line Protection

In ten minutes reading time, Alcoa's new 8-page booklet tells the exceptional economy of an Alcoa buried anode system for pipe-line protection. Your nearby Alcoa sales office will gladly supply sufficient copies for your organization.

MAGNESIUM

ANODES by ALCOA

ALCOA
ALUMINUM

• Continued growth through improvement of both processing facilities and product quality ... this is the end toward which most refiners are working today ... the end which many are achieving with the aid of the complete service offered by Universal Oil Products Company.

UOP

Frontier Throughput Up Nine Times Since 1940

By M. H. Robineau
Pres., Frontier Refining Company

In 1940 we founded the Frontier Refining Company as owners and operators of a small skimming plant on the outskirts of Cheyenne, Wyo. In our first year of operation, the daily crude oil throughput averaged 1,275 barrels.

M. H. Robineau

Today, after a consistent program of expansion and improvement carried out with the cooperation of Universal Oil Products Co., our daily throughput is approximately 11,000 barrels—nearly nine times that of our first year.

Total production of gasoline in 1940 was 7,576,000 gallons; in the year ended May 31, 1948, it was 56,500,000 gallons, and in addition, we produced other and readily marketable products.

Succeeds Marketing Company

Frontier Refining Co is the successor to Western Nebraska Oil Co. established in 1925 to market gasoline and other petroleum products to consumers in the small towns and on farms and ranches in the western part of the State. As the marketing business grew, the acquisition of an assured source of product supply became more and more desirable. Frontier became such a source.

Having placed our refinery in operation, our next objective was to increase the efficiency and economy of its operations and to improve the quality of its products. One of our first moves in that direction was to call in Universal Oil Products Co.

The result was installation of a UOP thermal cracking unit with a design capacity of 750 barrels per day which was placed in operation in the summer of 1941 and which has been in successful operation since that time.

War Record

Frontier has a war record of which we are all proud. Immediately after Pearl Harbor, we again called in Universal and worked out plans which were subsequently approved by the Petroleum Administration for War. These plans called for the installation of a separate aviation gasoline refinery employing the most effective processes and techniques to convert products derived from Rocky Mountain crude into components of 100-octane gasoline.

All elements of this refinery were designed and engineered by UOP. Prominent among them was a fluid catalytic

(Advertisement)

cracker of unique design. Many of the costly parts which had been incorporated in the earlier fluid units were eliminated to effect important savings in construction costs. Other processes in the aviation gasoline plant were UOP hydrogen fluoride alkylation, UOP butane isomerization, gas concentration and UOP thermal reforming.

This plant, which was built as speedily as the necessary materials could be obtained, was located on a site adjacent to the existing refinery, so that gases produced by the thermal cracking unit and other facilities in the Frontier plant could be readily transported to the new units as raw materials for the production of 100-octane gasoline components.

The new facilities, which were owned by the Defense Plant Corporation and operated by the Frontier organization, went into service on Feb. 22, 1944. Between that date and Aug. 15, 1945, the plant delivered more than 30,000,000 gallons of high octane aviation gasoline.

Government Plant Purchased

At the close of the war, we assumed operation of the new government plant on a rental basis and used it to manufacture high quality commercial gasoline until the spring of 1947 when we purchased the facilities outright.

A program of converting and improving the combined refineries was undertaken at once and is still in progress.

Among the many projects either completed or under construction at this time, are a catalytic polymerization unit, a new vacuum unit, a new thermal cracker, road oil and asphalt blending facilities, new boiler plants and loading docks, a steam line connecting the two plants, and a Unisol treating unit. Storage facilities have been expanded in several instances.

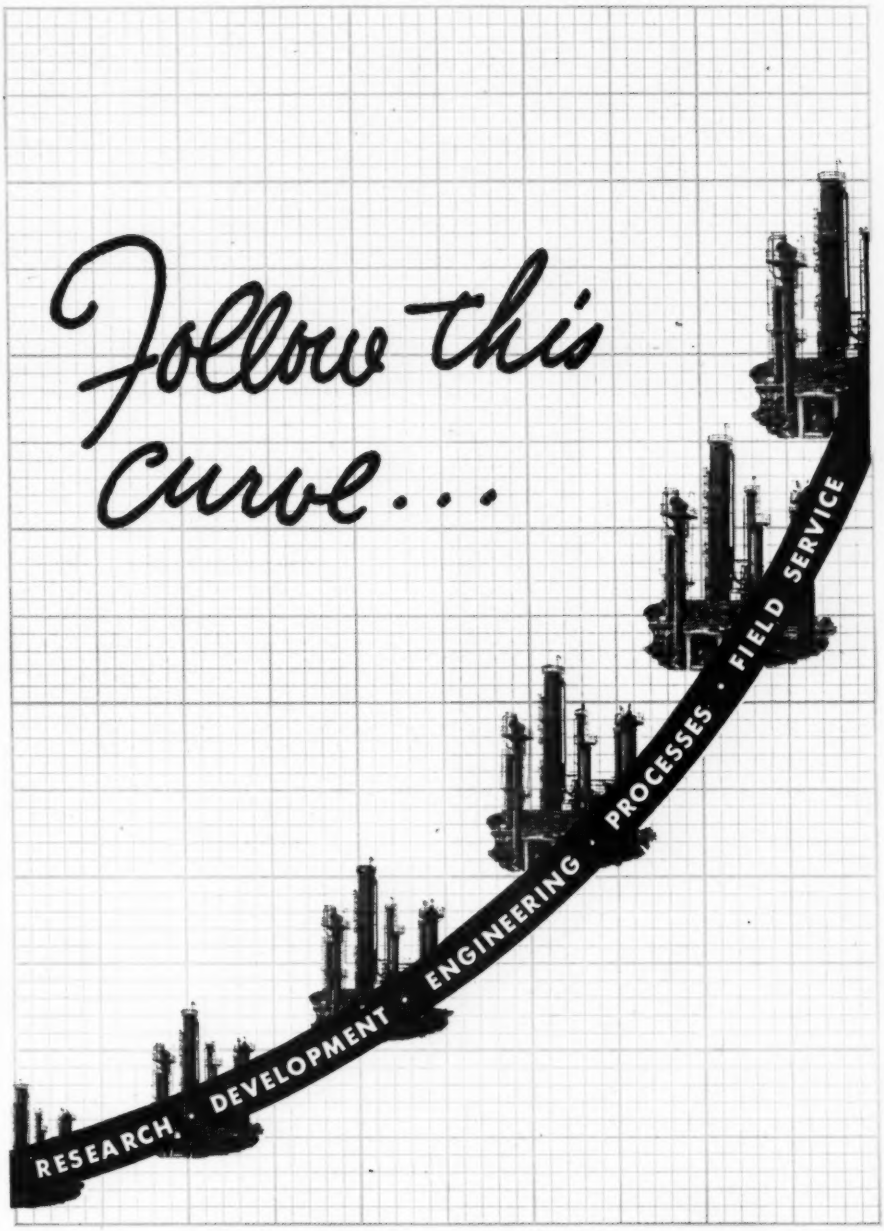
Valuable assistance has been received from Universal Oil Products Co., both in negotiating the purchase of the government plant and in its conversion to peacetime operation, as well as in the designing and engineering of the new facilities.

Drilling and Marketing

In addition to our program of plant improvement and expansion, we have, for the past several years, pursued an aggressive campaign of exploration and drilling. This already has achieved considerable success and it is hoped that it will eventually make Frontier entirely self-sufficient as to crude supply.

Our sales organization is currently marketing "Rarin'-to-Go" brand gasoline and certain other products in Wyoming, western Nebraska, South Dakota, Colorado, Utah and Idaho. While a few bulk plants and retail outlets are company-owned, the independent jobber is the backbone of the Frontier marketing structure. Road oils and asphalts are marketed in Nebraska, South Dakota, Wyoming, Colorado, Minnesota and Wisconsin.

(Advertisement)



• Graphically, it is the curve of sound, steady growth based on Universal service . . . a service that combines a thorough understanding of processing operations with the ability to translate this understanding into profitable action for the refiner.

UNIVERSAL OIL PRODUCTS COMPANY

UOP

General Offices: 310 S. MICHIGAN AVE., CHICAGO, ILLINOIS, U.S.A.
LABORATORIES: RIVERSIDE, ILLINOIS

Universal Service Protects Your Refinery

Here is the Diaphragm Motor Valve Body

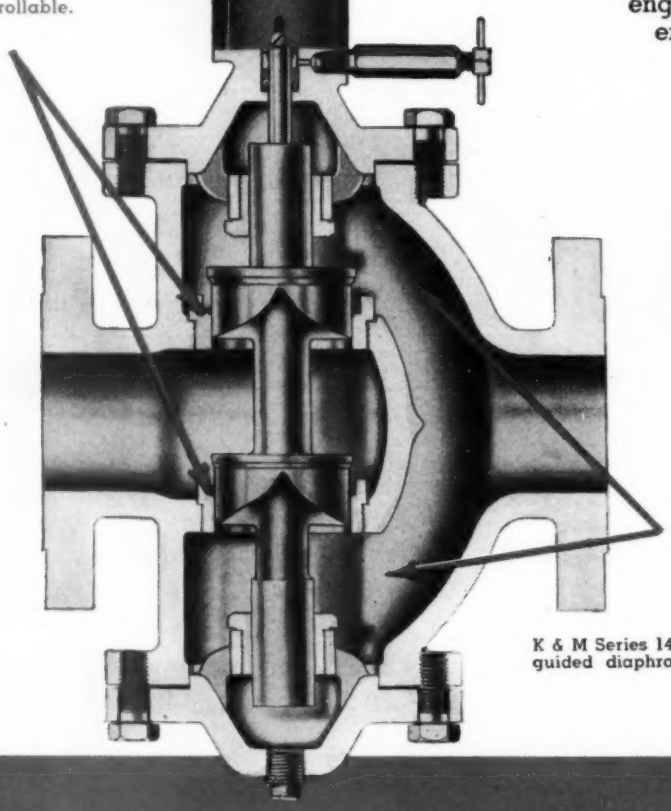
DESIGNED ESPECIALLY FOR INSTRUMENTATION

K & M Kontrol Motor valve bodies are especially designed to assure close and positive control by instrumentation. They have unrestricted inlet and discharge passages and permit smooth flow with a minimum of turbulence. Pressure drop is held to a minimum and occurs principally through the inner valve where it is controllable through the full valve travel.

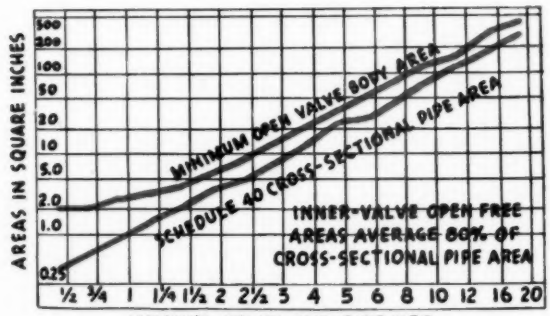
Kontrol Motor valve bodies are available in sizes from ½- to 20-inch, complete with diaphragm top works, and are made in 13 different types to meet varying requirements. Constructed of semi-steel, bronze, cast steel or special alloys.

Inner valves in beveled quick opening, percentage parabolic or percentage V-port design as standard. Facings range from soft rubber to hard stellite. Designed and manufactured for modern industry, they are engineered throughout to stand up to the most exacting applications.

Pressure drop occurs principally through the inner valve where it is controllable.

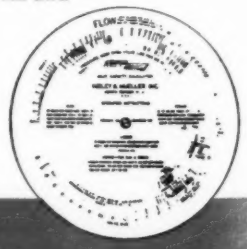


K & M Series 1400 top-and-bottom guided diaphragm motor valve.



Because of their modern design, all Kontrol Motor valve bodies have extremely high capacities in relation to corresponding pipe size.

Over-size, streamlined body areas reduce turbulence and friction to a minimum and assure smooth, maximum flow.



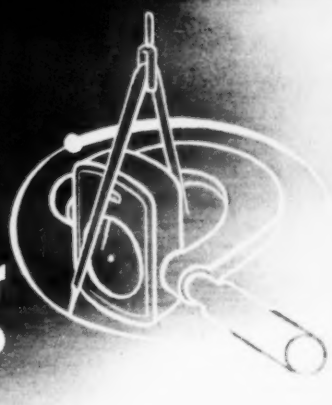
KONTROL MOTOR

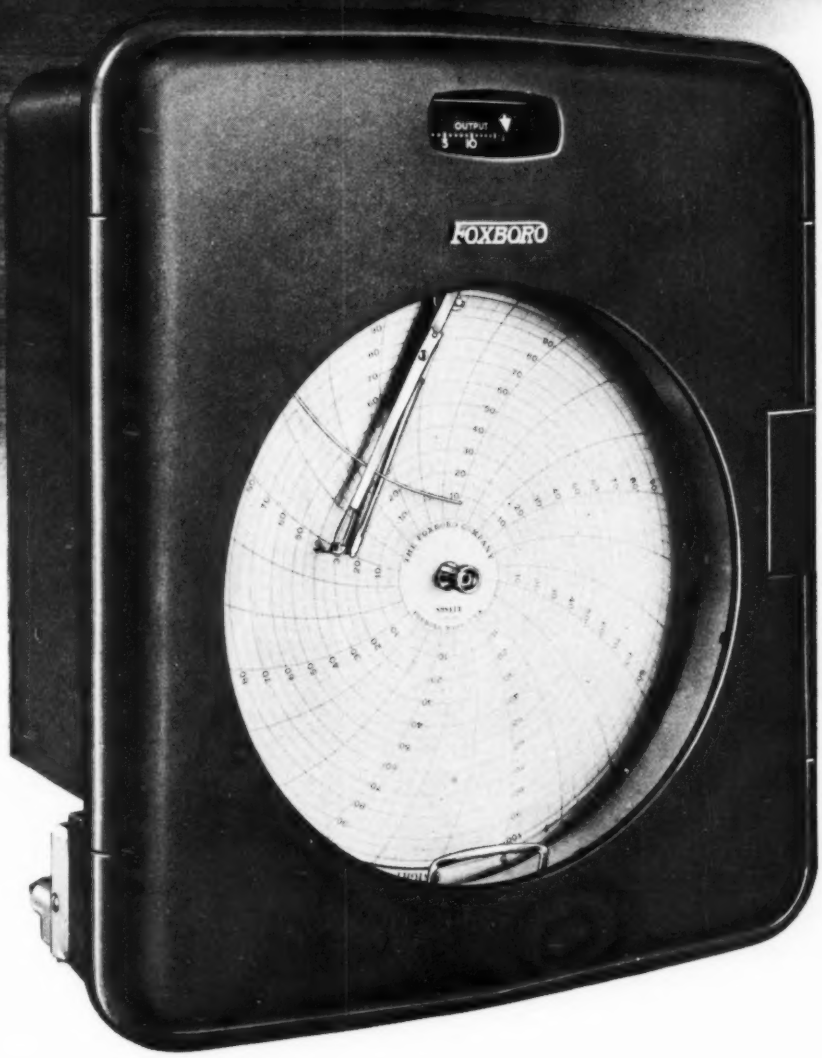
NORTH BERGEN, N.J.

ESTABLISHED 1879

This extremely accurate circular, slide-rule type K & M valve capacity calculator includes correction scales for steam quality, liquid and gas specific gravity and a flowing temperature scale for gases. Sent without charge in response to a request on your business stationery.

AN "EYE-OPENER" IN
Advanced Engineering





EVERY KNOWN REQUIREMENT of leading industries, every proved scientific advance in pneumatic control, every advantage of unmatched research and experience has guided the design of this truly modern controller. The results are simpler and more rugged construction, easier and permanently stable adjustments, unequalled performance.

Some M-40 parts such as the ball-pivot link and reset resistance are basically new. The entire mechanism presents a new criterion of simplicity and strength. Parts are made to machine tool precision and permanently aligned. Everything about the M-40 reflects advanced engineering, from its smoothly contoured front surface to its foolproof unit construction.

Such advanced engineering assures a long and profitable service life . . . another reason why more than 15,000 Model 40 Controllers have been purchased in the past 2 years.

FOXBORO
REG. U. S. PAT. OFF.

M-40

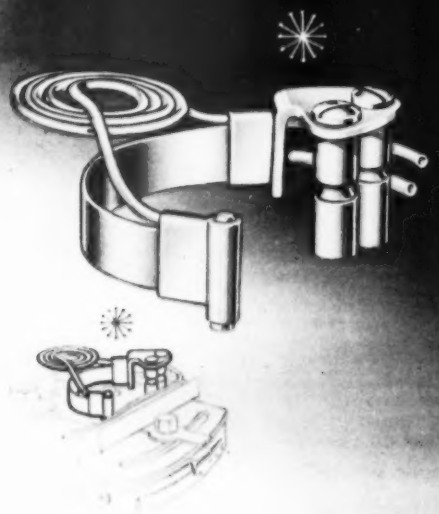
"THE FINEST MODERN CONTROLLER"

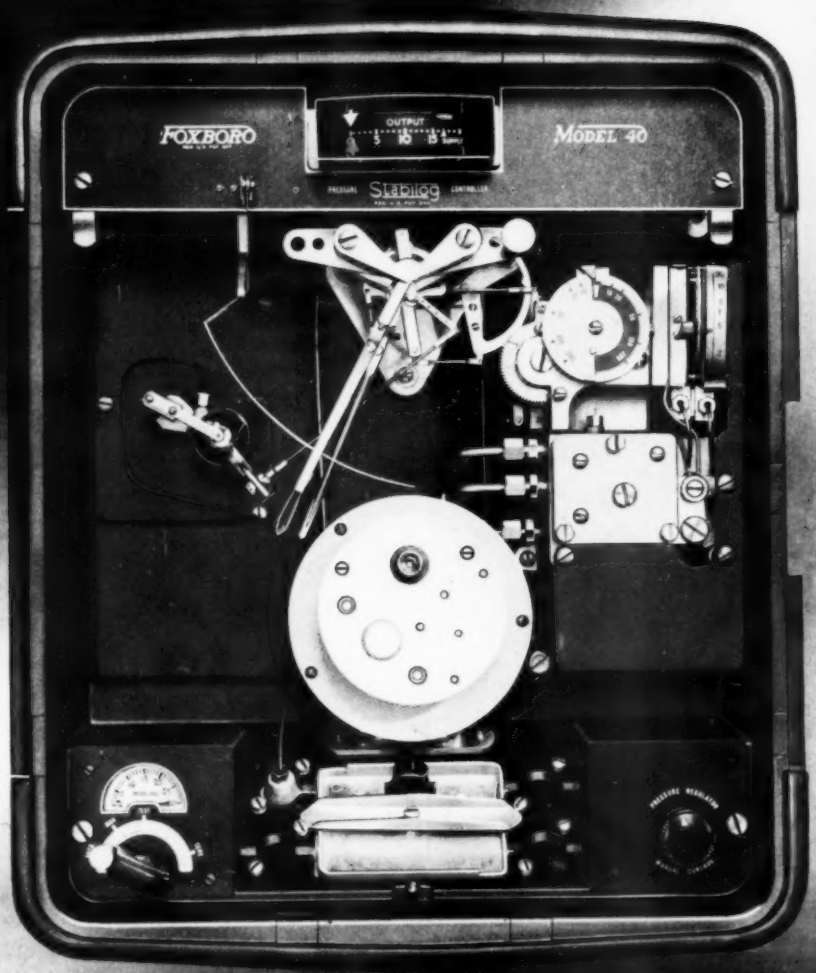
AN "EYE-OPENER" IN RESET ACTION

1949

Radically New Conception of

WIDE RANGE RESET RESISTANCE





Wide-range, stepless, variable reset resistance is obtained without the use of needle valves or lengths of capillary tubing. No possibility of plugging . . . no critical setting to obtain precision adjustments. Movement of the setting lever changes flexure of a simple Bourdon Tube, varying its cross sectional area through a range of 500 to 1, permitting correct reset adjustment for any process. The reset scale, graduated in time-constant units, is logarithmic . . . therefore retains uniform sensitivity of setting over its entire range.

Hyper-Reset derivative action makes use of matched resistances placed side by side and calibrated so that optimum process control is obtained when both adjusting levers have the same setting. Both adjustments are reduced to a single operation!

The Model 40 Pneumatic Controller is available for temperature, pressure, flow, liquid level, humidity, density, etc., in a full range of control actions and combinations. Write for Bulletin 381. **The Foxboro Company, 262 Neponset Avenue, Foxboro, Mass., U. S. A.**

FOXBORO
REG. U. S. PAT. OFF.

M-40

"THE FINEST MODERN CONTROLLER"

FOR

FLAMMABLE LIQUID AND GAS FIRES....

...WHEN DISASTER THREATENS..

PIONEERS OF DRY CHEMICAL

ANSUL

REG. U.S. PAT. OFF.

FIRE EXTINGUISHING EQUIPMENT

DRY CHEMICAL FIRE TRUCKS

Get the facts. Send for your copy of specifications and copy of File No. 414. You'll also receive our latest literature with comparative rating charts for the various types of fire extinguishers.

...YOUR *BEST* PROTECTION

In the event of a fire emergency — not minutes — but FRACTIONS OF SECONDS, count. And the split-second fire stopping power of Ansul Dry Chemical can turn a headline disaster into a routine operation.

The Ansul Dry Chemical Fire Truck is a product of combined chemical and engineering research. The greater effectiveness of Ansul Fire Extinguishing Equipment, on flammable liquid fires, has been established by repeated tests conducted by nationally recognized approval laboratories . . . and proved conclusively by the broad preference for Ansul Fire Extinguishers on the part of the Petroleum Industry.

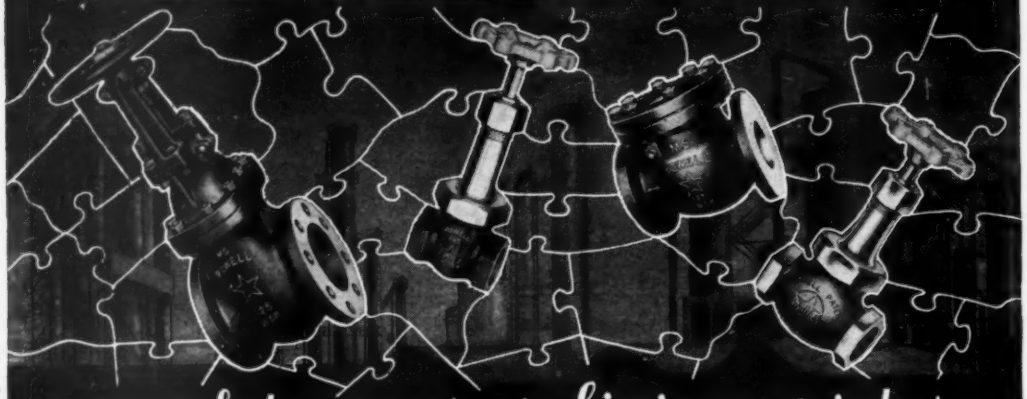
Regardless of your present equipment . . . type or quantity . . . an Ansul Dry Chemical Fire Truck provides the FASTER FIRE-STOPPING POWER you need during the critical seconds when disaster is in the balance.

ANSUL CHEMICAL COMPANY

FIRE EXTINGUISHER DIVISION, MARINETTE, WISCONSIN

DISTRIBUTORS IN PRINCIPAL CITIES IN THE UNITED STATES, CANADA, AND OTHER COUNTRIES

It takes POWELL VALVES *to complete your refining picture*



Naturally, to complete a jig-saw puzzle, you need all the pieces. And, for your complete oil refining picture you must have all the valves necessary to meet every existing flow control condition in your refinery.

Of course there are Powell Valves of standard design—in Bronze, Iron or Steel—for all the services for which these valves are adapted.

But modern refining processes have imposed many unusual demands. Powell meets them all with a *complete* line of High Pressure, High Temperature Valves* in special Alloy Steels and many Special Designs. These valves are especially adapted for service in making—

BUTADIENE — STYRENE — AVIATION GASOLINE — TOLUOL — BUTANE — BUTYLENE — ETHYLENE — PROPANE and other BASE PRODUCTS.

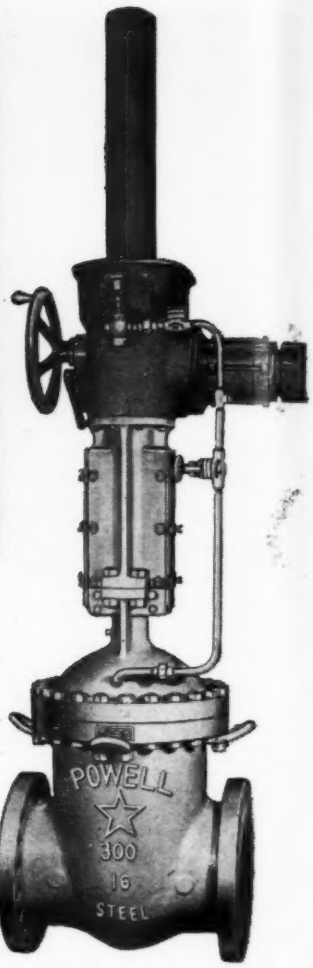


Fig. 3023—Class 300-pound Cast Alloy Steel Gate Valve with automatic steam sealing mechanism. Has explosion proof electric motor operator.

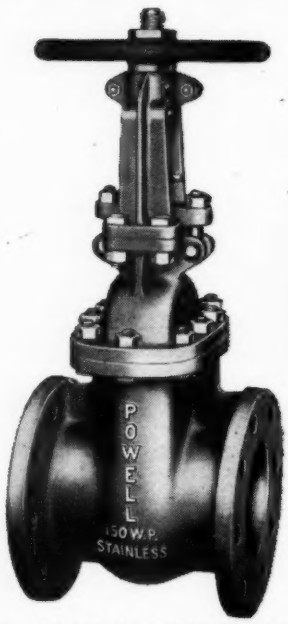


Fig. 2453-G—Large 150-pound Stainless Steel O. S. & Y. Gate Valve. Made in sizes 5" to 30", inclusive.

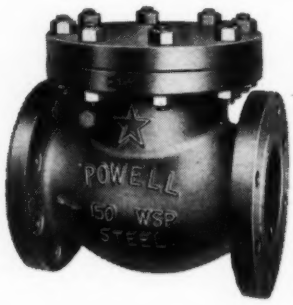


Fig. 1561 — Class 150-pound Cast Steel Swing Check Valve.

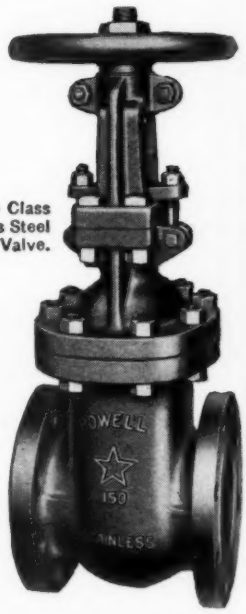


Fig. 1503 S. S. — Class 150-pound Stainless Steel O. S. & Y. Gate Valve.

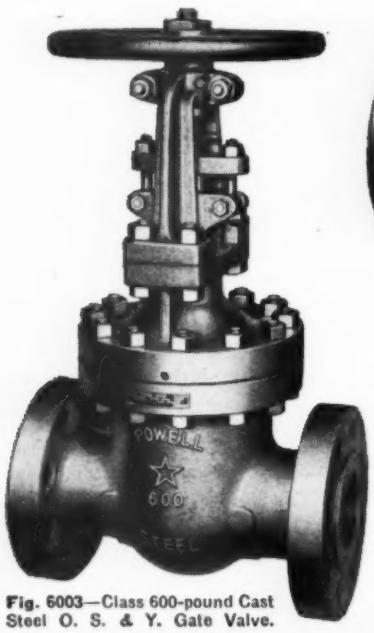


Fig. 6003—Class 600-pound Cast Steel O. S. & Y. Gate Valve.

*These valves can be made of various alloy steels, including corrosion-resisting and heat-resisting alloy steels; also with special trim parts. They are scientifically designed and have been especially built to handle the constantly increasing temperatures and pressures as well as the highly corrosive and erosive fluids encountered in the processing of hydrocarbons; to handle hydrogen chloride in isomerization and diisopropyl plants; hydrofluoric acid, sulphuric acid and sodium hydroxide in alkylation plants; for liquid and solid catalytic cracking; hydrogenation, dehydrogenation, hydroforming, polymerization, the regeneration of catalysts; for controlling flue gases and hydro carbons in transfer lines, and for handling sour crudes.

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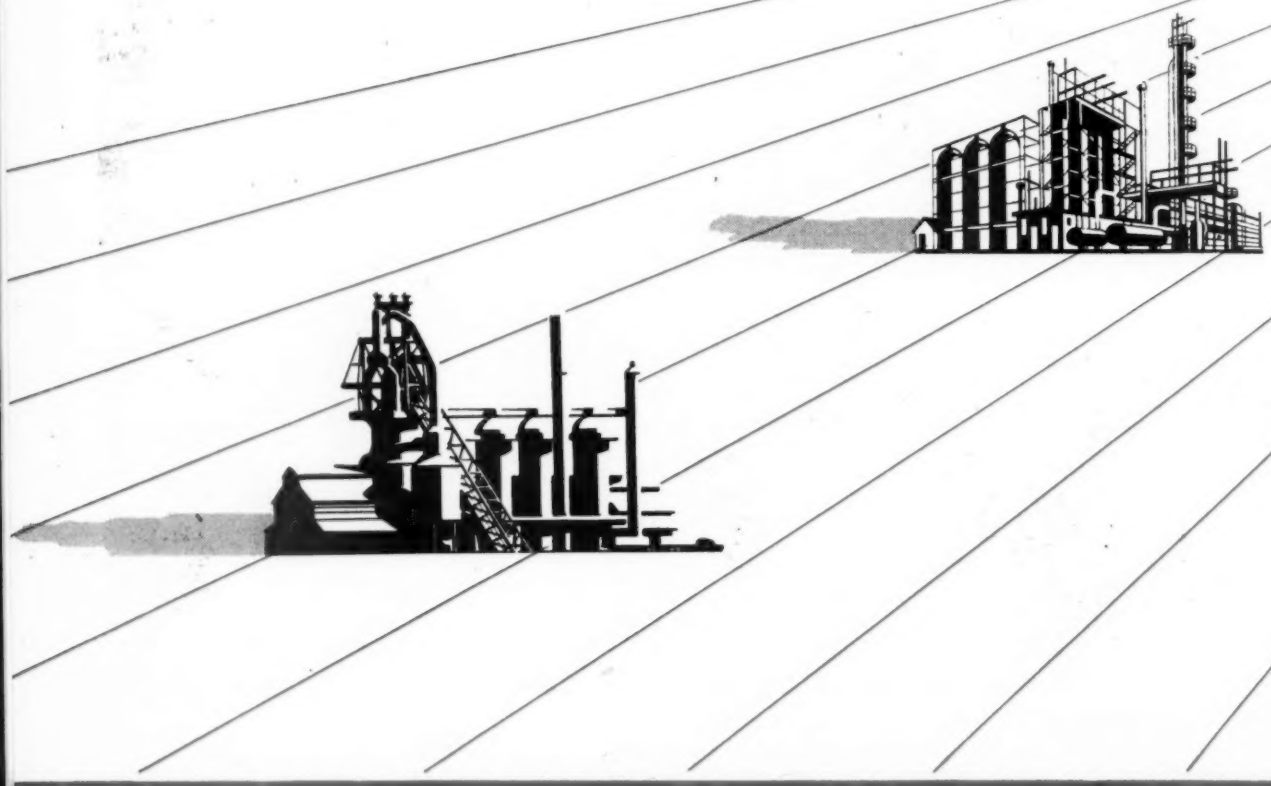

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APRIL, 1949

A PETROLEUM PROCESSING SURVEY

Petrochemicals in the Southwest

Survey Shows Oil Company Activity in Making Chemicals Is Carefully Planned, Maturing Slowly

By WILLIAM F. BLAND
Engineering Editor

WITH the close of the war, many opinions were expressed that oil companies, their appetites whetted by the large-volume butadiene and synthetic rubber operations, would step into the organic chemical business on a scale patterned after their conventional petroleum processing operations.

Now, nearly four years later, the smoke has cleared away, and a survey just conducted by PETROLEUM PROCESSING in the Southwest, heart of the petrochemical industry, shows that:

1) Less than a third of the total petrochemical investment there is in the hands of oil companies.

2) Of the six largest operators, only one (Shell) is oil-company owned; four (Carbide, Celanese, Dow, duPont) are strictly chemical firms; one (Ethyl) is jointly owned by oil and automotive companies.

3) Of 18 active firms, only six (including two fertilizer manufacturers) are entirely oil-company owned, with two more half-owned by oil companies.

The figures on which these statements are based are tabulated in Table 1. The operations included in the table do not cover the synthetic rubber phase of the industry, still in a state of flux and largely government-owned.

Chemical Firms Will Expand

As far as the immediate future is concerned, most indications are that the bulk of expansion in the field will be made by the chemical firms—not the oil industry. And the only major new entry now contemplated is rumored to be a chemical firm—Tennessee Eastman.

Oil companies aren't out of the petrochemical business by any means (witness Shell and McCarthy), and the next five or ten years may see radical changes in the present picture.

One petrochemical official we talked to is still of the opinion that the oil companies could, if they wanted to, take over the organic chemical industry practically at will. He emphasizes, however, the *could* part of his statement. He definitely doesn't think they *should*—and he further believes that if they were to try and do it they'd probably go about the venture on such a large scale as to knock the bottom out of the market for most organics and lose their collective shirts in the attempt.

He has a high opinion of the future for oil company ventures in petrochemical operations—but only if the oil companies learn that they aren't dealing with the same sort of

TABLE 1—Investment in Petrochemical Plants in the Southwest

Company Name	—Estimated Current Investment(1)— Petroleum Industry	Chemical Industry
Carbide & Carbon Chemicals Corp.		$ 32,000,000
Celanese Corp. of America		25,000,000
Cities Service Oil Co.	$ 2,000,000	
Commercial Solvents Co.		22,000,000
Diamond Alkali Co.		100,000
Dow Chemical Co.		35,000,000
DuPont de Nemours & Co.		78,500,000
Esso Standard Oil Co.	12,000,000	
Ethyl Corp.(2)	15,000,000	15,000,000
Jefferson Chemical Co.(3)	11,000,000	11,000,000
Lion Oil Co.	17,000,000	
Mathieson Chemical Corp.		7,000,000
McCarthy Chemical Co.	5,000,000	
Monsanto Chemical Co.		15,000,000
Phillips Chemical Co.(4)	12,000,000	
Rohm & Haas Co.		6,000,000
Shell Chemical Co.	54,000,000	
Spencer Chemical Co.		16,000,000
TOTALS	$128,000,000	$262,600,000

(1) Where available, company figures have been used. Otherwise, estimates have been based on the best available data. Government plants sold to private operators have been valued at the actual selling price, not the inflated original construction cost.
(2) Owned jointly by Standard Oil Co. (N. J.), and General Motors Corp.
(3) Owned jointly by The Texas Co. and American Cyanamid Co.
(4) This figure does not include the value of the government-owned Cactus Ordnance Works which Phillips is now operating on lease.

large-volume products that they are accustomed to in the liquid fuels field.

When the typical, well-established chemical firm develops a new chemical and begins producing it on a commercial scale, he goes on to explain, they do so in a sensible manner. They don't rush in and make as much as they can at as low a price as they can, regardless of current market demand. They move more slowly — with a moderate level of production and a high enough price to provide a respectable profit at the low volume. Gradually, over a period of years, they push their market development work, interest new customers in new uses, and push production up while at the same time they lower prices. With prices going down and uses going up, they eventually develop a large-volume item—but not over night.

A typical example of such a development, he pointed out, is ethylene glycol. It was over a quarter of a century ago that Carbide & Carbon first marketed its chlorhydrin-based ethylene glycol—at $1.00 a lb. During that period output has jumped from 10,000 lbs. in 1922 to an estimated 350,000,000 lbs. in 1948, and the price has dropped to a current 15c a lb.

Cities Service First—in 1926

The growth of the petrochemical industry in the Southwest has been concentrated for the most part in the past 8 or 9 years, with only scattered earlier plants. Cities Service was the first in the field, with its oxidation plant at Tallant, Okla., reportedly built in 1926,(8) producing methanol, acetaldehyde and formaldehyde. The Jersey Standard people were active in chemical research for some years prior to the 30's, and they were the next with a successful commercial venture, in about 1936—ethyl chloride, at Baton Rouge. The Ethyl Corp. followed quickly, also at Baton Rouge, making components for its Ethyl fluid.

For the following five years, the few new plants that went up were built in the Texas Gulf Coast area but there were only three—Dow at Freeport, Carbide & Carbon at Texas City, Shell at Houston. It is estimated that up to the start of the war only about $65,000,000 had been invested in the petrochemical industry in the Southwest.

Under the impetus of the war, new plants sprung up over-night, but mainly for making ammonia (explosives), butadiene, styrene and synthetic rubber. Most of them were government-built — and probably added over $500,000,000 to the investment in the area. One notable addition was the Celanese plant at Bishop, begun in 1943 to relieve the shortage of certain critical chemicals.

Private Capital Takes Over

Private capital started expanding in the area as soon as the end of the war was in sight, and many new faces came into the scene—DuPont at Orange and LaPorte, Jefferson at Pt. Neches, Rohm & Haas at Houston, and Lion Oil at El Dorado, to mention a few.

Today, PETROLEUM PROCESSING estimates, the total petrochemical investment in the Southwest is close to $725,000,000—including nearly $300,000,000 in government-owned butadiene and rubber plants.

As for the future, we estimate that another $250,000,000 will be invested in petrochemical plants in the area by private firms during the next five years. That estimate is based upon plans already announced or indicated, and our own ideas of what existing plants may expand.

One thing appears certain. As far as the supply of petroleum hydrocarbons for raw materials, there appears to be little concern that any shortages will develop—although the costs may go up.

The olefins—usually ethylene—are the most commonly used raw materials, although a good deal of methane is now used and in some cases propane and butane. Refinery gases from catalytic cracking operations, generally rich in the unsaturates, supply a portion of the required ethylene. Most plants have to augment those supplies, however, by cracking the light saturates, principally propane.

LPG Has "Alternate Use" Value

One big problem now facing many petrochemical operators using propane is the "alternate use" value of LPG as a fuel. One company, for example, which cracks propane to ethylene, today is paying about twice as much for its propane as it was 5 or 6 years ago—and last year they were paying three times as much. The main reason for this increase, according to the plant manager, is that the demand for propane as a fuel has risen to the point where it commands a premium price—"and those of us who use it for chemical processing have to follow along."

That's one bad feature of the petrochemical industry. Although a big user of such items as natural gas and LPG for raw materials, it doesn't use enough to be the primary consumer, and therefore it has little if any influence on the price structure. The big users are those who buy for fuel purposes, and if they are willing to pay more for the materials, the chemical outfits have little choice but to follow along—or find some other raw materials.

As for propane itself, its greatest drawback is the seasonal nature of the market for the material as LPG, with its wide fluctuations dependent to some extent upon the caprices of the weather.

Several people we talked with in

WHAT IS A PETROCHEMICAL?

In gathering information and data for this general roundup of the Petrochemical industry in the Southwest, the staff of PETROLEUM PROCESSING met a number of perplexing questions. Not the least of these was "Just exactly what do you mean by a Petrochemical?"

At first glance, the answer is simple—any chemical compound made with a petroleum hydrocarbon as one of its basic raw materials and involving the addition of one or more elements. Strictly speaking, that definition still holds, but it excludes some of those materials today commonly included in any discussion of the Petrochemical industry.

Styrene made from petroleum ethylene and butadiene made from petroleum butanes are still only hydrocarbons; and synthetic rubber made from the two is not even a chemical compound but rather a mixture of hydrocarbon polymers. Yet the synthetic rubber industry is generally considered a part of the Petrochemical industry.

And when does a Petrochemical stop being a Petrochemical? Ammonia made from natural gas certainly fits our definition—but how about the sulfate fertilizers made from the ammonia, or the nitric acid made from the ammonia and then reacted with more ammonia to give nitrates?

We've included the natural gas-ammonia-fertilizer and the synthetic rubber industries as part of the Petrochemical picture—more from a desire to adhere to popular practice than from strict interpretation of our definition. The synthetic rubber and butadiene plants themselves, however, are not discussed in this present article. A story to appear in May will list the plants and their present status, and discuss the future outlook for the industry.—W.F.B.

McCarthy Chemical Co.'s new plant near Winnie, Texas, is unique in that it is the first one to employ "tonnage" oxygen. The oxygen unit is at left (see pg. 377 for detailed view and story), chemical plant in center, and gas absoption plant at right

the industry, however, feel that the next few years should see a leveling off of the propane supply and demand picture. Demand will continue to rise, they think, but supply will be more on an even par with it—so that a company will be able to have some assurance of a steady supply and a steady price. One factor which is helping the situation is the increasing state conservation activities, since each new conservation measure usually results in additional propane recovery.

Could Switch to Ethane

Many propane users could probably use ethane just as well as far as the chemistry of the picture is concerned. And it might prove a more stable source of raw material. But it does have several disadvantages. In the first place, the only practical means of moving it is via pipeline, whereas propane can be liquefied and shoved around in tank trucks, tank cars and even barges. That means, if you want to use ethane, that you must be located fairly close to a steady source of supply of the material (certainly an advantage in any plant operation, but usually not a necessity). Supplemental to that problem is the difficulty of storing ethane—so that any shutdown in your supply source won't curtail your own operations. One obvious solution is not to depend on one lone source, but to have several; another is to provide standby propane reserves for such a situation, which is expensive.

Another difficulty is that ethane isn't as easy to separate from the other constituents of natural gas as propane is, requiring higher operating pressures—which makes it less desirable for the absorption plant to pull out. In fact, it is doubtful if most plants now operating and not designed for ethane recovery would be able to convert to the recovery of that material, at least not without considerable expense.

But these very disadvantages inherent in ethane may in the long run prove to be an advantage to the chemical user. Since ethane is difficult to move except by pipeline, it isn't likely to be used as a fuel in the way that LPG is. And if a goodly supply is ever made available, it isn't likely to be subject to the same price fluctuations that LPG is.

Propane for petrochemical uses, in general, has a purity of about 95+% C_3's, in conformance with specifications of the Natural Gasoline Assn. Actually, the specifications do not spell out the percentage composition, but they limit the vapor pressure of the material, and these limits are such that not much more than 5% C_2's can be tolerated. In addition, propane usually contains a very small quantity of material heavier than C_3. Here again the specifications do not place a limit on percentage, but by the "mercury freeze test" these heavier components are limited to 1 to 2%.

Propane originating in natural gasoline or cycling plants is, from the chemical point of view, saturated. On the other hand, material obtained from refining operations quite frequently contains an appreciable quantity of olefins—usually ethylene and propylene.

Fuel Gas Is Hard to Find

Aside from whatever problems there may be with respect to hydrocarbon raw materials, one really big difficulty that is becoming more prevalent is the supply of fuel gas. Strange as it may seem there's a shortage of the stuff—at least if you try to buy it in Texas.

Two reasons for this situation were advanced to us by an engineer with a major gas transmission firm in the Gulf Coast area. For one thing, he claims, the large transmission companies with pipelines to the East can find a ready market along the East Coast for all the natural gas they can bring into the area—and with the current coal and fuel oil prices it doesn't make too much difference whether that gas has to sell in the East for 50c or 75c per mcf. The

transmission companies can pay almost anything they have to for gas at the well head, tack that increase onto their delivered price, and still have more demand than they can fill. The net result is that the gas producers in the Southwest won't sell to local firms for only 3-6c per mcf, as in the past, when they can get as much as 13-15c from the transmission company. That puts the squeeze on the chemical company looking for a steady supply of fuel for his projected plant, unless he is willing to meet the higher price—which he usually is unwilling to do.

Most chemical manufacturers figure they can't afford to pay more than 3-6c per mcf for their fuel in the Southwest, even though they might pay ten times that for it in the east. They contend that the previous low cost of fuel has been one of the factors which has made it possible for them to come into the Southwest and make chemicals, most of which have to be shipped back East to get to their markets. If the low fuel costs are no longer low, then they might as well stay in the east with their markets.

Some Reserves Kept Idle

There's another factor said to be playing a part in the shortage of fuel gas—and that is that some of the biggest reserves are just being sat upon by their owners. "Why," they say, "should we sell you our gas reserves for what you're willing to pay for them today, or even for what the gas transmission company will pay us? We can hold the things, and in a few years or so they'll bring us twice as much return as they would today. We'll wait."

One typical example of what this situation means is found in the stymied plans of a major operator who wants to locate a new plant in the southwest, and is looking for both raw materials and fuel gas. The raw materials he has been able to line up without too much trouble, from cycling and natural gasoline plants, but finding dry natural gas is the stumbling block. Last we heard he was shopping around for a reserve which he could buy for his own operation, taking out the heavier products for raw materials and burning the dry gas for fuel.

Ethylene Glycol Expansion Seen

Of all petrochemicals, ethylene glycol and formaldehyde are most important.

Further expansion of ethylene glycol capacity in the Southwest probably will be announced shortly. Aside from a growing demand for the material as an antifreeze agent, another new use which may develop into a tonnage market is on the horizon—as an intermediate in the manufacture of Terylene.

Terylene is a synthetic textile fiber, produced by the esterification of ethylene glycol and terephthalic acid. The material was originally developed in England by the Calco Printers Assn. and Imperial Chemical Industries, Ltd., and is said to possess properties which make it superior to nylon and the rayons in some respects[3]. Development work in this country is being carried on by DuPont, and an official with one research laboratory recently told us that "one of our great chemical companies is using ethylene glycol and terephthalic acid as the chemicals in the synthesis of a new textile in the nature of Orlon, . . . and it is going to be on the market soon."

DuPont, incidentally, a few months ago announced that it had purchased 1700 acres of land at Victoria, Texas, 120 miles southwest of Houston. The company's ammonia department at that time was reported to have made preliminary studies of the site with a view toward building a plant there to make nylon intermediates. If DuPont's work on Terylene has been as fruitful as indicated, then the intermediate will probably be ethylene glycol.

Jefferson has unannounced expansion plans on the shelf—and may well increase its ethylene glycol capacity if its half-parent, The Texas Co., believes its antifreeze market can support the added volume.

Shell Chemical, subsidiary of Shell Oil Co., is another logical and potential entry into the ethylene glycol field. Many of Shell's petrochemical operations are based on the conversion of hydrocarbons through chlorination, and the company is already making hexylene glycol. Further, the parent oil firm, with its widespread marketing operations, is in a position similar to Texaco with respect to having a ready-made antifreeze market.

Floz-On Manufacturing Co. of Pittsburgh, a newcomer to the field, is erecting a plant at Houston, and purportedly plans to make ethylene glycol on a large scale. The company up to mid-March, however, had declined to confirm much more than the fact that a plant was being built for petrochemical operations using natural gas.

Formaldehyde Picture Unstable

The formaldehyde picture is probably the most unstable one right now in the entire petrochemical industry. The material was in exceedingly short supply during the war, when production capacity was about 500,000,000 lbs. a year. All market surveys indicated that the immediate postwar demand would be approximately 700,000,000 lbs. annually, and based on that prediction a number of manufacturers began enlarging their facilities, while at the same time new ones entered the field.

Celanese Corp. was the first big producer to expand after the war, at its Bishop plant. That unit went on stream in 1946, and has an annual capacity which has been estimated at 150,000,000 lbs. More recently, McCarthy Chemical Co. (the same McCarthy who recently opened the Shamrock Hotel in Houston) has entered the field with its new plant at Winnie, which was reported to have been completed last fall but is just now getting into production. That plant is estimated to have a capacity of about 200,000,000 lbs. annually.

The net result is that the bottom has literally fallen out of the formaldehyde market, and the January issue of the Commerce Dept.'s monthly report on the chemicals and drugs industries stated that "there now appears to be some concern whether certain of the unfinished capacity (formaldehyde, methanol and acetone) should be brought into production at this time."

Basically, there are two processes for making formaldehyde — conversion from methanol, or direct oxidation of natural gas. The conversion method, using methanol made either from natural gas or by fermentation, dominated the field until recently. Both the Celanese and McCarthy

Government-Built Ammonia Plants and Present Status

Cactus Ordnance Works, Etter, Texas; leased to Phillips Chemical Co. for fertilizer operations.

Dixie Ordnance Works, Sterlington, La.; sold to Commercial Solvents Corp., who has added methanol facilities.

Jayhawk Ordnance Works, Galena, Kans.; sold to Spencer Chemical Co., who has expanded ammonia capacity and added methanol facilities.

Mathieson Alkali Works ammonia plant, Lake Charles, La.; sold to Mathieson Chemical Corp., who is operating facilities as originally built.

Ozark Ordnance Works, El Dorado, Ark.; sold to Lion Oil Co., who has expanded and added fertilizer operations.

San Jacinto Ammonia Works, Houston, Texas; now being set up with equipment transferred from Missouri Ordnance Works at Louisiana, Mo.; to be operated by Hercules Powder Co.

plants, however, operate on the direct oxidation process, eliminating the methanol step.

It is generally conceded that the direct oxidation operators now appear to have an edge, and seem to have indicated their ability to make formaldehyde at a much lower cost than the conversion people. They face one difficulty—it is presently practical to make formaldehyde in only about a 37% solution, which means that for every 37 lbs. of formaldehyde they make and ship, they also have to ship along about 63 lbs. of water. That wouldn't be too bad if the markets were just a few miles away. But remember that the direct oxidation process uses natural gas, and the natural gas is available cheaply only in the Southwest area. And since about 80% of the formaldehyde market, according to one estimate, is situated on the Atlantic Coast, the direct oxidizers have to move a lot of water around the country. Higher concentrations than the present 37% solution would appear to be the solution, and some operators are rumored to be experimenting in that direction, but at the higher concentrations the material becomes less stable, tending to polymerize and form paraformaldehyde.

Celanese Goes to Tankers

Celanese has taken probably the biggest move yet to beat the problem of transportation that is connected with this chemical. They recently started shipping formaldehyde from their Bishop plant near Corpus around the coast and up to New Haven, Conn., via a specially-designed tanker, in contrast to the conventional method of tank car shipment. Some sources doubt, however, that Celanese has actually gained too much of an economic advantage, considering that they have to move the material from their Bishop plant to Corpus Christi on the Gulf Coast, a matter of about 50 miles, maintain terminal facilities at Corpus and also at their unloading port of New Haven, and then provide transportation from the New Haven terminal to the customer. With tank-cars you handle the chemical once at the plant to load it, move the car around the country, and unload it at your customer's plant—considerably less handling, with less labor costs, fewer chances for contamination, and little likelihood of losses.

Celanese has, however, shown the feasibility of moving in tonnage volume chemicals previously confined to tank car shipment and small lots.

Others besides Celanese have used tanker shipments in the past, primarily in the movement of caustic, and barge shipments have been common for some chemicals. Dow is reported used barges for moving styrene; Carbide & Carbon, McCarthy, DuPont and Shell are said to be actively studying the possibilities of moving finished products by tanker.

There's another side to the picture of bulk shipment, too, and that is that many petrochemicals are expensive and made only in relatively small lots. A refiner who turns out a product worth only 5-10c a gal. and makes thousands of gallons a day, can afford to ship by tanker. But the petrochemical manufacturer who makes only a thousand pounds of a product each day usually can't let that product stand around his plant for weeks until he accumulates enough to fill a tanker. He has to get it out of there and to his markets—or else he'll soon find all his capital tied up in inventories.

Although the petrochemical picture in some spots isn't too rosy, not everyone is discouraged. One oil company which has shelved its chemical expansion plans thinks the industry has just gone too far too fast—and that it will take a few more years for things to shake themselves down and smooth out—but smooth out they must.

Who's Where—Making What?

BELOW are brief discussions of individual petrochemical operations in the Southwest, arranged alphabetically by company name. These are not intended as complete descriptions of the facilities of any plant, but have been prepared to give an over-all, up-to-date picture of the industry. A summary of the data is given in Table 2.

Cactus Ordnance Works, Etter, Texas, has been leased to Phillips Chemical Co. for fertilizer operations.

Carbide & Carbon Chemicals Corp., a subsidiary of Union Carbide & Carbon Corp., has been active in the southwest since 1941. It has behind it, however, years of petrochemical experience, with its plants at South Charleston, W. Va., put into operation in 1925, and at Whiting, Ind., in 1935.

The present site at Texas City was purchased in 1938, and construction of the plant began in June, 1940, with the first production unit going into operation in May, 1941.

By the beginning of the war the plant had eight units in operation, but had achieved only about half of its planned capacity. With the cessation of hostilities, a $15,000,000 post-war expansion was started, and by the end of 1948 75% of that program had been completed. Total investment at the plant when expansion is completed, which is expected this summer, will be about $32,000,000, according to the company.

Major products of Carbide & Carbon at Texas City, accounting for over 50% of the total plant output, are ethanol, ethylene glycol, acetic anhydride, acetone and isopropanol. Other important products are butanol, vinyl acetate and vinyl chloride (which are further processed into "Vinylite" resins), and ethyleneamines (ethylene diamine, diethylene triamine, triethylene tetramine, and tetraethylene pentamine). Still other secondary products include butyl acetate, isopropyl acetate, ethyl ether, ethylene dichloride, and ethylene oxide.

Principal hydrocarbon raw materials are ethylene and propylene, which for the most part are separated from cracked refinery gases purchased from the nearby Pan American Refining Corp. plant. In addition, the plant cracks light saturated hydrocarbons to augment its supplies, and also purchases the olefins as such from other minor sources.

Units completed last year included major additions to the ethanol and ethylene glycol facilities, and new units for the production of vinyl compounds. Additional ethanol capacity will be completed in 1949, as well as facilities for making "Vinylite" resins from the vinyl compounds.

Carthage Hydrocol, Inc., is erecting at Brownsville, Texas (at the southern end of the Gulf Coast, almost to the Mexican line) the first commercial plant for the synthesis of liquid fuels from natural gas. The plant is now under construction and is expected to be in operation late this year or early in 1950.

As by-products of the fuel synthesis operation, the plant will turn out over 150,000,000 lbs. annually of a number of important organic chemicals, as given below:(6)

Compound	Production (lbs. per year)
Acetaldehyde	9,100,000
Propionaldehyde	1,930,000
n-Butyraldehyde	3,750,000
Acetone	11,200,000
Methanol	730,000
Methyl ethyl ketone	4,780,000
Ethanol	63,680,000
n-Propanol	14,400,000
n-Butanol	4,370,000
n-Amyl alcohol	1,060,000
Acetic acid	24,700,000
Propionic acid	8,700,000
Butyric acid	8,200,000
Methyl propyl ketone	600,000
TOTAL	157,200,000

U. S. Industrial Chemicals, Inc., and Stanolind Oil & Gas Co. (which has dropped its own plans for a synthesis plant at Garden City, Kans.)

have entered into an arrangement with Carthage Hydrocol for purchasing, purifying and marketing the by-product chemicals.

Celanese Corp. of America is the foremost producer today of petrochemicals by direct oxidation of hydrocarbons. Its "Chemcel" plant at Bishop, Texas, about 25 miles southwest of Corpus Christi, has mushroomed during the past five years into a $25,000,000 operation.

The oxidation process had been developed and the plant planned before the war, but it was shelved during the emergency until 1943, when the shortage of certain critical chemicals was so acute that the War Production Board decided Celanese should go ahead with the project. Production was started in 1945, the principal products being acetic acid, acetone, formaldehyde, acetaldehyde and methanol.

By 1947 the Chemcel plant had become the leading producer of organic chemicals, and added large scale production of n-propanol, and iso-propanol, butanols and methylal. Also produced at that time but since discontinued were tetrahydrofuran, propionic acid, and methyl ethyl ketone.

Last year propionaldehyde was produced in drum lots, and Celanese entered the glycol field with its 2-methyl-1, 3-pentanediol. This year the company expects to further process its 4-carbon alcohols to n-butanol and iso-butanol. Other glycols are under study, and pentaerythritol and acrolein are anticipated as future products.

Propane and butane, to the extent of an estimated 300,000 gals. daily, are the hydrocarbon raw materials, brought in by pipeline. Principal supply sources are the LaGloria Corp., 25 miles to the southwest, and the Chicago Corp., 10 miles away.

Research work for Celanese's petrochemical operations is carried out at the company's Petroleum Research Center at Clarkwood, just outside Corpus Christi. This center was put into service early in 1947, represents an investment of well over $1,000,000 and is responsible not only for process improvement and new product application but also develops ideas for additional chemicals which might be made at Bishop.

Cities Service Oil Co. is the "granddaddy" of the petrochemical industry in the southwest—and the pioneer in the direct oxidation of the lower paraffin hydrocarbons to valuable oxygenated compounds.

It was some 25 years ago that Cities Service (then the Star Oil Co., and later the Empire Oil & Refining Co.) was pumping gas from its Oklahoma fields to Chicago and having trouble with pipeline corrosion. The difficulty, after some investigation, was thought to be caused by oxygen contained in the gas. In attempting to remove the offending oxygen by promoting oxidation over a catalyst, the company found itself with a process that produced appreciable quantities of formaldehyde and other oxygenated chemicals.

The first commercial plant using an oxidation process of this type was constructed at Tallant, Okla., in 1926.[8] Cities Service is still operating a plant there for the manufacture of methanol, formaldehyde and acetaldehyde, although its capacity is dwarfed by the more recent oxidation plants installed by Celanese at Bishop and McCarthy at Winnie, Texas.

Commercial Solvents Corp. purchased the government ammonia plant (Dixie Ordnance Works) at Sterlington, La., near Monroe, and last fall completed a $5,000,000 expansion program which provided the company with 45,000 gals. daily additional methanol output.

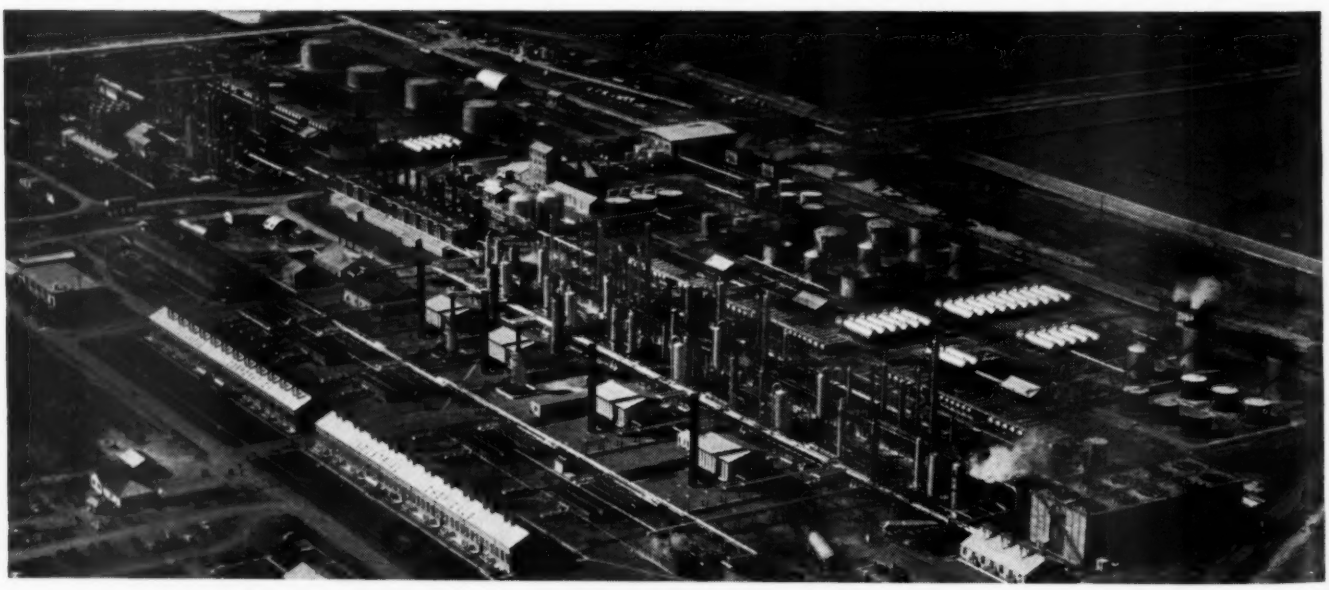
Diamond Alkali is just on the verge of becoming a commercial operator in the petrochemical industry in the Southwest. At its new caustic-chlorine plant near Houston the company has installed a semi-commercial plant to produce perchlorethylene, operating on a process which Diamond developed in its laboratories near Cleveland.

Perchlorethylene is competitive with carbon tetrachloride as a dry cleaning solvent. The material has two notable advantages—it is less corrosive on dry cleaning equipment, and is somewhat less toxic. But it also has a major disadvantage—it costs more. Dow is presently the only large producer in the Southwest, at its Freeport plant.

For the present, Diamond will obtain its ethylene requirements from the adjacent Shell Oil Co. refinery, via pipeline. As for the future, the company might install cracking equipment and separate the ethylene from heavier hydrocarbons—if the present operation indicates that a full-scale plant is warranted.

Dixie Ordnance Works at Sterlington, La. (near Monroe) has been sold and is now being operated by Commercial Solvents Corp.

Dow Chemical Co. is one of the oldest petrochemical operators in the Southwest—with two plants, one at Freeport, Texas, and the other at Velasco, just across the Brazos



Aerial view of the greatly expanded Chemcel plant of Celanese Corp. of America at Bishop, Texas

TABLE 2—Products and Hydrocarbon Raw Materials of Petrochemical Plants

Company	Location	Hydrocarbon Raw Materials	Principal Petrochemical Products
TEXAS			
Carbide & Carbon Chemicals Corp.	Texas City	ethylene and propylene (refinery gases, cracking of propane)	ethanol, ethylene glycol, acetic anhydride, acetone, isopropanol, butanol, vinyl acetate, vinyl chloride, vinyl resins, ethyleneamines
Carthage Hydrocol, Inc.	Brownsville	methane (natural gas)	acetaldehyde, proprionaldehyde, n-butyraldehyde, acetone, methanol, methyl ethyl ketone, ethanol, n-propanol, n-butanol, n-amyl alcohol, acetic acid, propionic acid, butyric acid, methyl propyl ketone
Celanese Corp. of America	Bishop	propane and butane	methanol, acetaldehyde, formaldehyde, propionaldehyde, acetic anhydride, acetic acid, acetone, butanols, n-propanol, iso-propanol, methylal
Diamond Alkali Co.	Houston (Deer Park)	ethylene (from Shell Oil)	perchlorethylene
Dow Chemical Co.	Freeport and Velasco	methane (natural gas), ethylene and propylene (cracking of ethane-propane mixtures)	styrene, ethylene glycol, diethylene glycol, triethylene glycol, propylene glycol, methylene chloride, ethylene dibromide, ethylene dichloride, carbon tetrachloride, chloroform, perchlorethylene, hexachlorethane
E. I. DuPont de Nemours and Co.	Orange	methane (natural gas), ethylene (cracked from propane), cyclo-hexane	methanol, polythene, nylon salts
	LaPorte	(not known)	benzene hexachloride
Floz-On Mfg. Co.	Houston	methane (natural gas)	ethylene glycol or methanol
Jefferson Chemical Co.	Pt. Neches	ethylene (refinery gases)	ethylene glycol, ethylene oxide, ethylene dichloride, diethylene glycol
McCarthy Chemical Co.	Winnie	methane and ethane (natural gas)	methanol, acetaldehyde, formaldehyde
Monsanto Chemical Co.	Texas City	ethylene (refinery gases, cracking of propane)	styrene
Phillips Chemical Co.	Etter	natural gas	anhydrous ammonia, nitric acid, fertilizer
	Houston	.....	ammonium sulfate fertilizer, using ammonia from Etter
Rohm & Haas Co.	Houston (Deer Park)	methane (natural gas)	hydrogen cyanide, acetone cyanhydrin, ethylene cyanhydrin
San Jacinto Ammonia Works (U. S. Govt.)	Houston	natural gas	anhydrous ammonia, fertilizer
Shell Chemical Co.	Houston (Deer Park)	ethylene, propylene, butylene (refinery gases)	ethanol, ethyl chloride, iso-propanol, acetone, epichlorohydrin, glycerin, allyl alcohol, allyl chloride, butylene glycol, sec. butyl alcohol, methyl ethyl ketone, methyl isobutyl ketone, methyl isobutyl carbinol
LOUISIANA			
Commercial Solvents Co.	Sterlington	methane (natural gas)	anhydrous ammonia, methanol
Esso Standard Oil Co.	Baton Rouge	ethylene and propylene (refinery gases)	ethanol, iso-propanol, ethyl chloride, ethyl ether, isopropyl ether
Ethyl Corp.	Baton Rouge	ethane and ethylene (refinery gases)	ethyl chloride, ethylene dichloride, tetraethyl lead
Mathieson Chemical Corp.	Lake Charles	natural gas	anhydrous ammonia
OKLAHOMA			
Cities Service Oil Co.	Tallant	methane (natural gas)	methanol, acetaldehyde, formaldehyde
ARKANSAS			
Lion Oil Co.	El Dorado	natural gas	anhydrous ammonia, nitric acid fertilizers
KANSAS			
Spencer Chemical Co.	Pittsburg	methane (natural gas)	anhydrous ammonia, nitric acid, methanol

River. The company originally came into the picture because of its interest in magnesium, which it obtained from seawater at Freeport. It wasn't long, however, before the abundance of cheap chlorine that was available caused Dow to expand into the manufacture of chlorinated hydrocarbons and their derivatives.

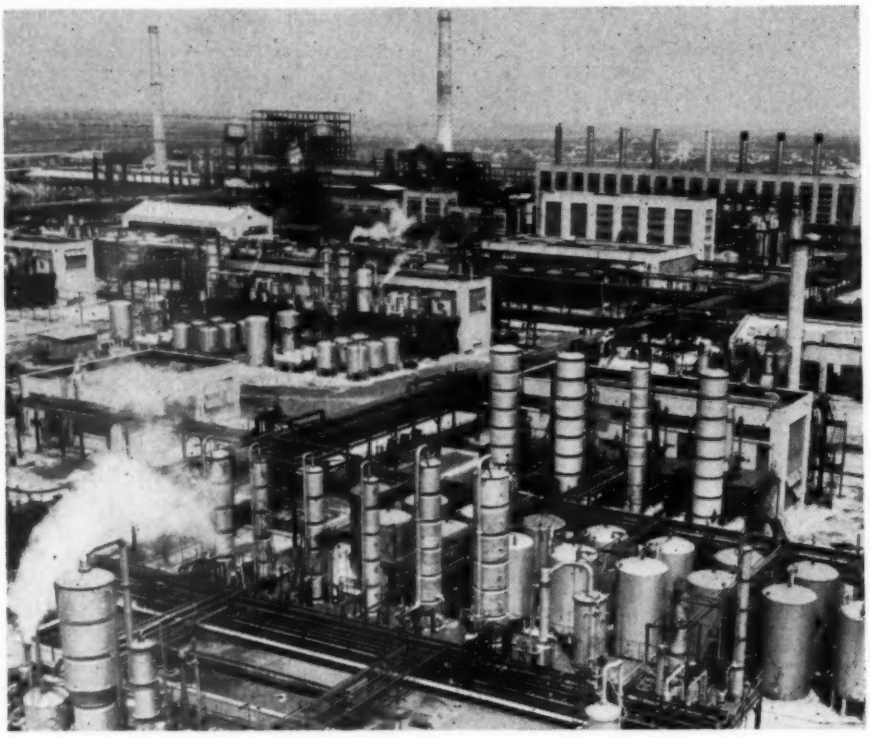
Total investment of the company in its two plants is reported to be over $150,000,000, but the bulk of this is for its magnesium and allied operations. This actual investment in petrochemical facilities is probably in the neighborhood of $35,000,000—including the government-built styrene plant which Dow purchased after the war.

Products made include styrene, ethylene glycol, diethylene glycol, triethylene glycol, propylene glycol, methylene chloride, ethylene dichloride, ethylene dibromide, carbon tetrachloride, chloroform, perchloroethane, and hexachlorethane.

Raw materials in the hydrocarbon field are methane, ethylene and propylene, the olefins being obtained by cracking light hydrocarbon fractions. Several years ago Dow was said to be receiving approximately 65,000 gals./day of ethane-propane mixture by pipeline from the Katy Cycling plant of Humble, and it was believed that takings could be increased to 100,000 gals. if need be. Another source is reported to be the Old Ocean cycling plant.

E. I. duPont de Nemours & Co. has two petrochemical plants and an investment estimated at $75,000,000 in the southwest, with a third major project expected to be announced shortly.

Largest of the operations is the Sabine River plant just outside



Carbide & Carbon's plant at Texas City started operating in 1941, and is now completing an expansion program which was cut short by the war. Principal products are ethanol, ethylene glycol, acetic anhydride, acetone and isopropanol

Orange, Texas, which was started in March, 1945, and first put into operation the following year, making nylon salt. Since then units have been added for the manufacture of methanol (by the catalytic reforming of natural gas methane) and polythene (by the polymerization of ethylene obtained by cracking propane).

The nylon salt made at the Sabine plant is based on adipic acid and hexamethylene diamine.[5] Hydrogen from natural gas is used in the manufacture of both these chemicals, as well as the required ammonia. In the past coal tar benzene was hydrogenated to cyclohexane for the adipic acid, but more recently Humble Oil & Refining at Baytown, about 75 miles to the west, has been producing an 85% cyclohexane fraction and supplying duPont's needs. Part of the adipic acid is employed to make the hexamethylene diamine. The nylon salt — hexamethylene-diammonium-adipate—is dissolved to facilitate handling and shipped in tank cars to other duPont plants.

A smaller plant is operated by duPont's Grasselli Div. at LaPorte, 25 miles east of Houston. The LaPorte works manufacture phenothiazine and benzene hexachloride, among other chemicals, but little is known concerning plant operations and raw material requirements.

A third duPont project has just recently been indicated. The company last November purchased 1700 acres near Victoria, Texas, on the Guadalupe River. An announcement was made at that time by duPont's Ammonia Div. that the site was being considered for a "plant to make chemical intermediates for nylon." As speculated earlier in this article, a strong possibility seems to exist that ethylene glycol may be made there.

Esso Standard Oil Co. at Baton Rouge, La., is one of the earliest petrochemical operators on the Gulf Coast, with a semi-commercial project for the manufacture of butadiene dating back to 1930. The first commercial development that really amounted to something worthwhile was started in about 1936, and was concerned with the manufacture of ethyl chloride from ethylene, for use by the Ethyl Corp. in tetraethyl lead.

Since then facilities have been expanded to include ethanol, isopropanol, ethyl ether and isopropyl ether. The most recent project started operating last fall—the first commercial production of iso-octyl alcohol by the new OXO process, and an increase in capacity is now contemplated.

Esso has also played a most important part in the synthetic rubber program—with one butyl rubber plant now in active operation and a second in standby, as well as standby butadiene facilities.

Ethyl Corp., owned jointly by General Motors and Jersey Standard, is now completing at Baton Rouge, La., substantial additions to its Ethyl fluid facilities. Included are units for ethyl chloride (from which tetraethyl lead itself is made) and for ethylene dichloride (which with the TEL, ethylene dibromide, a solvent and a dye make up the Ethyl fluid).

All hydrocarbon gases required in the operation, as well as hydrogen, are obtained by pipeline from the nearby Esso Standard Oil Co. refinery.

Floz-On Mfg. Co., of Pittsburgh, is one of the newest potential entrants into the petrochemical field. The company has in the past been a small manufacturer of such chemicals as automobile cleaners, waxes and polishes.

Although construction of their contemplated plant at Houston had not yet been started by mid-March, the contractor, the Austin Co., had moved onto the site and put up a few construction sheds. Contracts for furnaces, it is understood, have been let to Furnace Combustion Co. for $360,000. The present program, according to one Floz-On official, will run "several million dollars," and eventually may exceed $10,000,000.

Precisely what Floz-On expects to make isn't clear. The company has stated that one phase of operations will be conversion of methane to methanol by catalytic reforming directly from natural gas. Another source states that the company has developed in its pilot plant at E. Brady, Pa., a new method for producing ethylene glycol, consisting of catalytic reforming of methane to a 2-carbon olefin (acetylene or ethylene) and then catalytic hydration of the olefin to the glycol. A further development in the process, it is understood, may lead to the manufacture of synthetic glycerin—a point of much interest to Shell, which last fall put the world's first commercial synthetic glycerine plant into operation at Houston.

A letter that Floz-On is said to have circulated to prospective antifreeze jobbers last fall indicated that production was scheduled for May 1, 1949, and that the contemplated output would be approximately 25,000,000 gallons of ethylene glycol annually—a tremendously large output compared with the total estimated U. S. output of about 350,000,000 lbs. in 1948 (approximately 37,000,000 gals.).

Hercules Powder Co. will operate for the government the newly-established San Jacinto Ammonia Works, now being set up at the San Jacinto Ordnance Depot with equipment being moved there from the Missouri Ordnance Works.

Jayhawk Ordnance Works at Galena, Kans. (near Pittsburg), has been sold and is now being operated by Spencer Chemical Co.

Jefferson Chemical Co., which has been operating its plant at Pt. Neches, Texas, for about a year, was formed in November, 1944, as the logical consequence of a chemical company which wanted a stable source of supply of ethylene oxide, American Cyanamid, and a petroleum company which could use an abundance of ethylene glycol, The Texas Co. The operation is owned 50-50 by the two parents.

Primary products at present are ethylene oxide, ethylene glycol and ethylene dichloride, although the company is also currently producing as co-products diethylene glycol, aromatic distillate, and hydrocarbon polymer. What additional products may be produced in the future hasn't been revealed by the company, although one source has mentioned benzothiophene (thianaphthene) and some other thiophene derivatives as possibilities.

Ethylene is the basic raw material for the products now made, and is separated from refinery gases obtained from Texaco's nearby 135,000 b/d refinery at Pt. Arthur. The gases are carried approximately 5 miles through a 6- to 8-in. pipeline to the Jefferson plant, where they are treated to remove carbon dioxide and hydrogen sulfide, and then cracked, compressed and separated.

It is pretty generally known that Jefferson is utilizing chlorhydrination and alkaline hydrolysis to produce its glycols. Production capacity of the plant, however, is at best a guess. One source(1) gave its approximate ethylene production as 175,000 lbs. per day. Assuming chlorhydrination to yield the usual ratio of chlorhydrin to dichloride, another source(2) estimated this amount of ethylene should produce roughly 60,000 lbs. of ethylene dichloride and 230,000 lbs. of ethylene oxide equivalent per day.

Chlorine for the plant is shipped by tankcar (and possibly by barge) from the Southern Alkali Corp. plant at Lake Charles, La. Southern Alkali, by the way, is another subsidiary of American Cyanamid, being owned jointly by that company and Pittsburgh Plate Glass Co.

Research facilities for Jefferson have just recently been consolidated at Austin, where the company purchased 69 acres, including 5 buildings on 7 acres of improved land. Research, product development and pilot plant operations in the past have been carried out at New York City and Pt. Arthur, and will be moved as soon as the newly acquired property is remodeled to fit it for chemical research. Initial staff will be about 65 people. Austin, located about 240 miles from the Jefferson plant at Pt. Neches, is the site of the U. of Texas, which may offer Jefferson opportunities for cooperative research.

Lion Oil Co. now owns and operates for itself the former Ozark Ordnance Works which the government built at El Dorado for the manufacture of anhydrous ammonia during the war. Since taking over the property about a year ago for $10,500,000, Lion has undertaken a $5,500,000 expansion program to add sulfuric acid and ammonium sulfate facilities and to enlarge the ammonia capacity from about 430 tons to 570 tons per day.

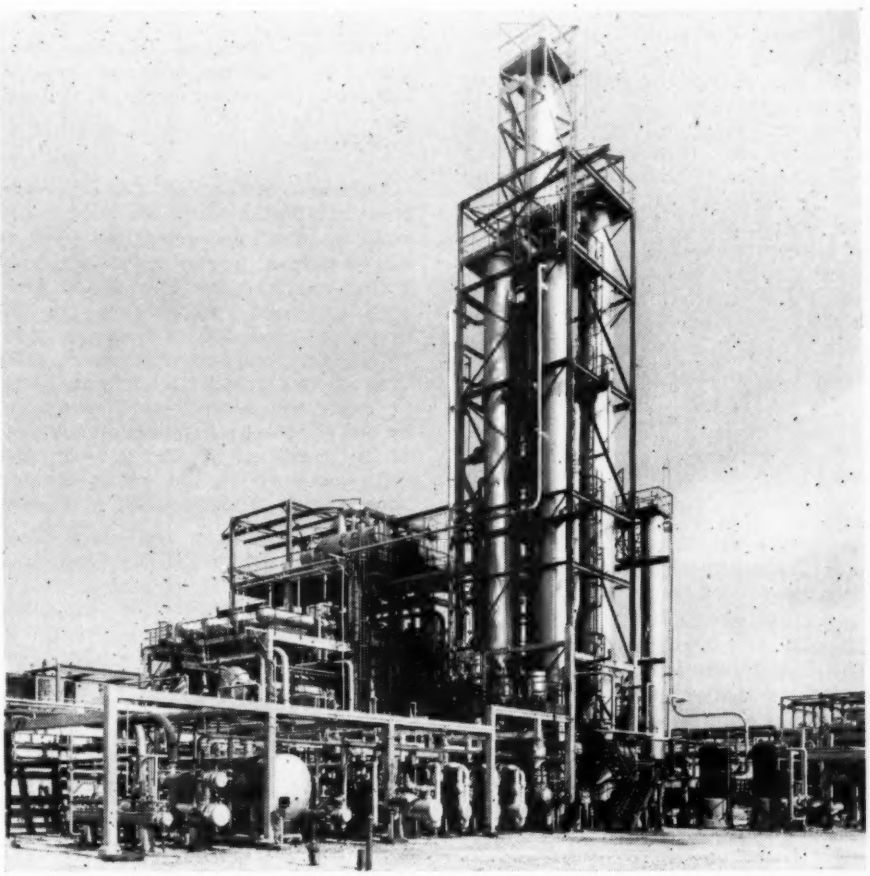
Ammonia from natural gas and the subsequent fertilizers are the present extent of Lion's petrochemical ventures, but the company has pointed out that its facilities could be modified to produce methanol, urea and formaldehyde.

Mathieson Chemical Corp. has purchased and is now operating for its own account the anhydrous ammonia plant built by the government during the war at Mathieson's Lake Charles, La., alkali plant. No changes or additions to the plant facilities have been made since its acquisition last August, according to the company. The plant has an annual capacity of 60,000 tons of ammonia.

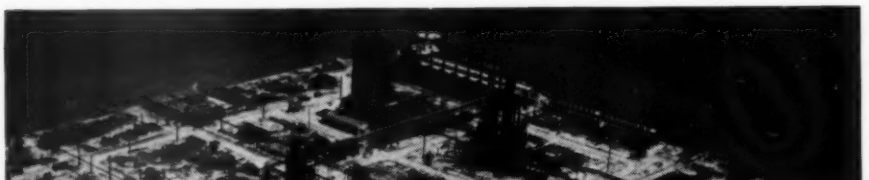
McCarthy Chemical Co. is the newest large-scale petrochemical operator in the field, with a plant near Winnie, Texas. The new plant, built at a reported cost of $5,000,000, was dedicated last November, but is understood to have gone into actual production just last month (March).

Products at present are methanol, acetaldehyde and formaldehyde, but past reports have credited the company with considering benzene "and other aromatics," and styrene, as well as with having plans for "the largest ethylene plant in the U. S." It is quite likely that these reports were put out in the early days of the project to conceal its true nature.

Raw materials for the operation are supplied in the form of natural gas after it has been processed in the adjacent McCarthy absorption plant to remove natural gasoline, butane and propane. The absorption plant has a capacity of 100-125,000,000 cu. ft. daily, and a second absorption plant with 50-60,000,000 cu.



General view of Jefferson's ethylene unit at Pt. Neches, showing fractionating towers and condenser structure. On ground at right is the incoming gas separator from which the gas flows into the first tower on the right, which is a portion of the Girbotol hydrogen sulfide removal system



Aerial view of the rebuilt Monsanto styrene plant at Texas City. The original plant was built by the government as part of the wartime synthetic rubber program, and operated by Monsanto—who bought the facilities in October, 1946. Six months later the fateful S. S. Grandcamp, berthed in the slip along side the Monsanto plant at the left, exploded while loading ammonium nitrate and practically leveled the Monsanto installation

ft. daily capacity is now building.

The use of elemental oxygen in the chemical operation is the most outstanding feature of the entire plant, and marks the first such commercial operation. The other two hydrocarbon oxidation units in the U. S. (Celanese at Bishop, Texas, and Cities Service at Tallant, Okla.) both use air for their oxidizing processes. The oxygen plant, designed and built by Stacey-Dresser Engineering, produces 175 tons per day of 95% oxygen. (An article, with photo and flow chart, describes this plant in more detail in this issue, pg. 377).

Another unusual feature of the operation is that the unreacted residue gas from the chemical processing step is turned into a pipeline and sold to the surrounding communities. Only the use of oxygen makes this possible, since otherwise the residue gas would be diluted with nitrogen from the air to the point where its Btu value would be too low.

As for capacity, one of McCarthy's competitors rates the plant at 200,000,000 lbs. annually of formaldehyde, or 40% of the estimated 1948 output.

Another approach to the plant's output is contained in a recent article:[4] "One hundred and fifty heated tank cars will be required for the shipment of the formaldehyde, which is to be supplied both as inhibited 37% solution and uninhibited 50% solution. The methanol will require at least 40 steel tank cars, while the acetaldehyde will need 50 of insulated steel." The company itself has stated that tank cars used for moving products are of 10,000 gal. capacity.

Military Chemical Works, Inc., was the wartime operator of the Jayhawk Ordnance Works at Galena, Kans., which has since been sold to Spencer Chemical Co.

Monsanto Chemical Co.'s styrene plant at Texas City was originally built by the government as part of the wartime synthetic rubber program, and was the first of the government plants to achieve production. Its rated capacity at the time design was started was set at 3000 tons a year, but that figure was progressively jumped to 20,000 tons by the time actual construction started in March, 1942, and later to 50,000 tons before the plant started operating in March, 1943.

Monsanto bought the plant from the government in October, 1946, and was in the midst of expanding it when the disastrous explosion of the ammonium nitrate-laden S. S. Grandcamp, on April 16, 1947, practically leveled the entire installation. Although little of the original equipment was useable, a virtually identical plant has been rebuilt on the site and is now in full operation.

Ethylene, separated from refinery gases or cracked from propane, is one of the principal raw materials, and the plant is reported to have a production capacity of 175,000 lbs. of ethylene daily.[1] Benzene is the other raw material, secured from coke oven gases.

Styrene is still the sole product of the plant, although polystyrene at one time was scheduled for production, and a $2,000,000 installation for its manufacture was under construction at the time of the disaster in 1947. Immediate plans for that operation have been dropped in the meantime, although it would still seem a possibility for further expansion.

Ozark Ordnance Works, El Dorado, Texas, has been sold to Lion Oil Co. for fertilizer operations.

Phillips Chemical Co. was formed just last year as a wholly-owned subsidiary of Phillps Petroleum Co. At present its operations are confined to fertilizers and synthetic rubber ingredients, although the company appears to have expansive plans for the future.

Last September Phillips acquired from the government the 338-acre Todd Shipyard property (renamed Port Adams) on the Houston Ship Channel, and has since constructed and begun operating facilities to produce ammonium sulfate fertilizer. When the operation was first announced the company stated that the investment at Port Adams "should easily amount to from 30 to 40 million dollars" within four or five years. Presumably petrochemicals are being considered, since Phillips has extensive oil and gas holdings in in the area.

Anhydrous ammonia for the Houston plant is supplied from the Cactus Ordnance Works at Etter, Texas, which Phillips leased from the government last fall. Phillips is now adding facilities to double the Cactus' ammonia capacity to over 140,000 short tons a year. In addition, the company is building near Etter its own nitric acid and ammonium nitrate facilities, which will utilize ammonia from the Cactus works.

At Borger, Texas, Phillips Petroleum Co. operates the government-owned butadiene plant, while Phillips Chemical has a large furnace-type carbon black plant which is unusual in that it operates on a liquid charge stock instead of the natural gas used in conventional carbon black plants.

Rohm & Haas Co. has at its new but relatively small plant at Deer Park on the Houston Ship Channel the beginnings of a varied petrochemical operation. At present the company is concerned only with the manufacture from methane and ammonia of hydrogen cyanide, and the further processing of the HCN with acetone and ethylene oxide, into, respectively, acetone cyanhydrin and ethylene cyanhydrin. The cyanhydrins are shipped east for further processing into methyl methacrylate

plastics (Plexiglas) and other materials.

Of the raw materials employed, only methane is produced in the plant, being separated from natural gas in a Union Oil Hypersorber unit. All the other raw materials, although petrochemicals, are brought in from the outside—and therein lies the potentiality for an enlarged petrochemical operation.

Recent reports indicate that Rohm & Haas intends to double the present capacity at Deer Park shortly, and eventually to manufacture methyl methacrylate there.

San Jacinto Ammonia Works near Houston is now being set up with equipment moved from the Missouri Ordnance Works at Louisiana, Mo., to the San Jacinto Ordnance Depot on the north side of the Houston Ship Channel. When completed the plant will be operated for the government by Hercules Powder Co., and will have a capacity of 2000 short tons of anhydrous ammonia a month, which will be converted to nitrogenous fertilizer.

Shell Chemical Co., wholly owned subsidiary of Shell Oil Co., now has at Houston what is probably the most expensive petrochemical operation in the whole Southwest—even if the variety of products isn't as great as that of some of the other large producers.

In 1941 the plant was valued at $4,000,000, and was producing isopropyl alcohol, acetone and butadiene. Today the plant is valued at $54,000,000 and is turning out about a dozen products in commercial quantities, including ethyl alcohol, ethyl chloride, isopropyl alcohol, acetone, epichlorohydrin, glycerin, allyl chloride, allyl alcohol, hexylene glycol, secondary butyl alcohol, methyl ethyl ketone, methyl isobutyl ketone, and methyl isobutyl carbinol.

Also listed by Shell as products, some on a semi-commercial scale, are acrolein, diallyl phthalate monomer, diallyl phthalate polymer, diallyl ether, mesityl oxide, diacetone alcohol, trichloropropane, and "D-D" (a soil fumigant). The butadiene operation was discontinued after the war.

Hydrocarbon raw materials for Shell's petrochemical operations are all olefins—ethylene, pyropylene and butylene. The butylene is obtained as such from the adjacent Shell Oil Co. refinery, while the ethylene and propylene are separated from mixtures of refinery gases or cracked from light saturates. Propylene is probably the biggest-volume material of the three gases, and Shell is now finding it necessary to go outside its refinery to find sufficient supplies. According to one Shell official, "already several of these plants (catalytic cracking) in nearby refineries of other oil companies are providing us with propylene to supplement that produced by our own Shell Oil units. . . . and the importance of these outside supplies will continue to increase as our operations expand."

Spencer Chemical Co., a postwar product formed after VJ-Day, is just on the fringe of the southwest, operating the former Jayhawk Ordnance Works at Galena, Kans. (near Pittsburg), which the company purchased last May for $11,000,000. The ordnance plant, which was run during the war by Military Chemical Works, Inc., originally included facilities for the production of anhydrous ammonia, nitric acid, and 83% ammonium nitrate solution. Spencer has added to the ammonia capacity and also put in methanol facilities.

An additional expansion program to add an estimated 30,000 to 40,000 tons annually to the ammonia capacity was announced just last month (March). Present capacity is estimated to be in excess of 10,000 tons per month of ammonia, and in the neighborhood of 2000 tons per month of methanol.

Rumors of Plants-to-Be

As in any operation of the magnitude and scope of the petrochemical industry, there are always a number of rumors floating around. These pretend to tell who is planning to do what, generally in a vague sort of way—and usually without confirmation.

In rounding up the information for the previous article, the editors of PETROLEUM PROCESSING naturally fell heir to a goodly portion of such items. In all cases, we followed through on them, trying to "smoke out" something definite or at least to get some sort of information from the principals involved.

One such rumor was the Floz-On Mfg. Co.'s operations in Houston, reported above, concerning which the company was expected to make a definite announcement late in March.

Others proved groundless—or at least as far as could be determined. Below are given, by company, as much information as we could dig out in each case. The reader can take it for what its worth, either as indicative of possible future operators in the field who aren't yet ready to talk, or merely as gossip, distorted by repeated telling. Quite naturally we aren't at liberty in all cases to tell our source, but we've tried to indicate as far as we can how reliable we think it is.

American Cyanamid owns about 900 acres of land at Pt. Neches, Texas, adjacent to the new petrochemical plant of Jefferson Chemical, of which American Cy is half owner. The company has long been rumored as contemplating its own petrochemical operations there, but since the emergence of Jefferson it will more than likely proceed with the further processing of part of Jefferson's output. Although no announcements as to what it has in mind have been made by American Cy, "obviously, we are making plans," as one company spokesman put it, "but I doubt if we'll be in a position to say anything publicly about them in the near future—at least not for a few months or longer."

Chemical Specialty Co. of Houston, which had been reported as manufacturing propylene glycol, was found to be not a manufacturer but merely a blender.

Cisco Hydrocarbons has recently completed an absorption plant at Moran, Texas, about 200 miles west of Ft. Worth, and according to one source was planning on "hanging a petrochemical plant on its tail." Inquiry to Fish Engineering Corp., which has a financial interest in Cisco, brought the statement that "we are not contemplating any chemical plant in the near future." A small methanol pilot plant which had been planned and announced has been shelved for the present.

General Chemical Div. of Allied Chemical & Dye Corp. may have plans for a petrochemical plant at Houston, according to two independent sources. When asked about any such plans, the company's reply was that "the information requested is considered confidential . . . and release for publication cannot be made," implying, therefore, that the reports may have some basis.

At its Baton Rouge, La., plant, General is said to be making fluoride compounds, two of which may be petrochemical in nature—ethylidene-fluoride and 1,1,1-difluorchlorethane, both reportedly used as low pressure gases for aerosol dispersants.

Houston Oxygen Co. at one time announced plans to build an acetylene plant at Houston, using for the first time in a commercial venture the Schoch process for converting natural gas to acetylene in an electric discharge. Although the plant has not yet been built and the company has no immediate program for going ahead with it, the company execu-

tive we talked with would not say that plans had been dropped entirely.

Humble Oil & Refining Co. was one of the major producers of butadiene during the war, operating a government-owned plant at its Baytown, Texas, refinery. Humble is still operating both the butadiene plant and the government-owned butyl rubber plant there. Its butadiene plant at Ingleside, Texas, however, has been shut down.

Although Humble purchased the former Baytown Ordnance Works at the close of the war, the company is not now manufacturing any petrochemicals, strictly speaking, except as noted above. It is using the facilities for making toluene, xylene and higher boiling aromatic solvents. It is also separating a cyclo-hexane cut (which DuPont is said to be using in its nylon salt operations at Orange), and a group of close-cut aliphatic solvents—n-hexane, heptane and octane.

Magnolia Petroleum Co., which during the war operated a government plant at Beaumont for the manufacture and recovery of toluene, is not now engaged in any petrochemical operations. The toluene plant itself was sold to Petrol Terminal Corp., which has removed the equipment to its refinery at Texas City for use in the construction of a new crude unit there.

Merichem Co. is a small Houston chemical manufacturer which several sources have indicated is readying a modest petrochemical operation. The company states that it has a plant under construction on the north side of the Houston Ship Channel (near Sheffield Steel's plant), and although officials do not deny that petrochemicals will be part of the output, neither have they as yet released any details. An announcement was expected early in April.

Pan-American Chemicals Division of Pan-American Refining Corp. (Indiana Standard subsidiary) is often classed as a petrochemical possibility, but for the present appears to be sticking to petroleum specialties — solvents, for the most part. Its chemical operations are carried out at Texas City, and products also include hydrocarbon drying oils and resins. An extensive research program is underway at Texas City, and future expansion may well be into the petrochemical field—but the company as yet has not confirmed any such steps.

Sinclair Refining Co. for some time has been reported to be readying plans for commercial petrochemical operations. On account of high construction costs, however, the company for the present has decided to confine itself to further development work and improvement of its processes in the petrochemical field. "We have a number of developments," one Sinclair official told us, "and, undoubtedly, some of them will be brought to large commercial developments." In the Southwest, Sinclair operates two large refineries, one at Houston and the other at Corpus Christi. The 50,000 b/d government-built butadiene plant at Houston which a subsidiary, Sinclair Rubber Co., operated during the war is now shut down and in standby status.

Southern Alkali Corp. when asked about a report that it was actively contemplating the manufacture of chlorinated hydrocarbons at its Corpus Christi caustic plant, replied that "we have no definite plans in this regard at present." The company is well fitted, however, through background and previous experience, to engage in such operations. It is owned jointly by Pittsburgh Plate Glass Co. and American Cyanamid Corp. Pittsburgh Plate Glass, through other subsidiaries, is now manufacturing phthalic anhydride and chlorinated benzene; American Cy, likewise through a subsidiary (Jefferson Chemical), is making ethylene golycol.

Stanton Chemicals, a new organization, should probably be listed with those companies included in the section on plants, but so little of a definite nature is known about what the company is planning to make, when it will start operations, or what its raw materials will be. In fact, it's not even certain that it should be classified as "petrochemical."

The company is building a plant at Corpus Christi, that much is known, and one recent report stated that it has already spent over $1,000,000 on three completed buildings, will continue construction and expansion through 1949, and is preparing to begin production early this year.

Stanton itself, in a recent release announcing the appointment of a manager of manufacturing, stated that its proposed operation involved "the maunfacture of aromatic-type hydrocarbon solvents, phthalic anhydride, anthraquinone, organic acids, and a variety of petroleum specialties." Other reports have listed such products as benzol, toluol, xylol, naphthalene, anthracene, alcohols, resins, halogenated and nitrated compounds, and lubricating specialties.

The chief chemist with an oil company told us he understood toluene and xylene would be used for raw materials, but he was at a loss to explain the source of such aromatics in the Corpus area, unless hydroforming was being employed. The use of coal tars from the Colorado Fuel & Iron coke plant at Pueblo, over 650 miles away, has been advanced as a possible source—but one which would take the operation out of the petrochemical class.

Tennessee Eastman Corp. is said to be looking around the southeastern part of Texas for a place to build an unidentified multi-million dollar chemical plant—probably petrochemical, since they were reported trying to line up ethane and propane supply sources. At its Kingsport, Tenn., plant the company now makes an estimated 170,000,000 lbs. of acetic anhydride annually,(7) starting with synthetic ethanol, which is dehydrogenated to acetaldehyde and then oxidized to acetic acid and dehydrated to the anhydride.

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First Tonnage Oxygen Plant Ties In With Petrochemical Manufacture

By JOSEPH E. BLUDWORTH
Petroleum and Chemical Consultant, Corpus Christi

HIGH-purity, low-cost "tonnage" oxygen for the petrochemical industry is now a reality. The first unit for manufacturing really large quantities of oxygen from air went on stream last month at the new plant of McCarthy Chemical Co., at Winnie, Texas, and is producing 175 tons per day of gaseous oxygen at 95% purity.

Designed and constructed by Stacey-Dresser Engineering of Cleveland, the unit is the first major, low-pressure, tonnage oxygen plant for the petrochemical industry—and possibly even the first one for all industry. The oxygen leaves the plant at 1.5 to 2.5 psig. Other tonnage oxygen plants have been planned and even built, particularly for the steel industry, but as far as is known none of them are as yet actually in successful operation.*

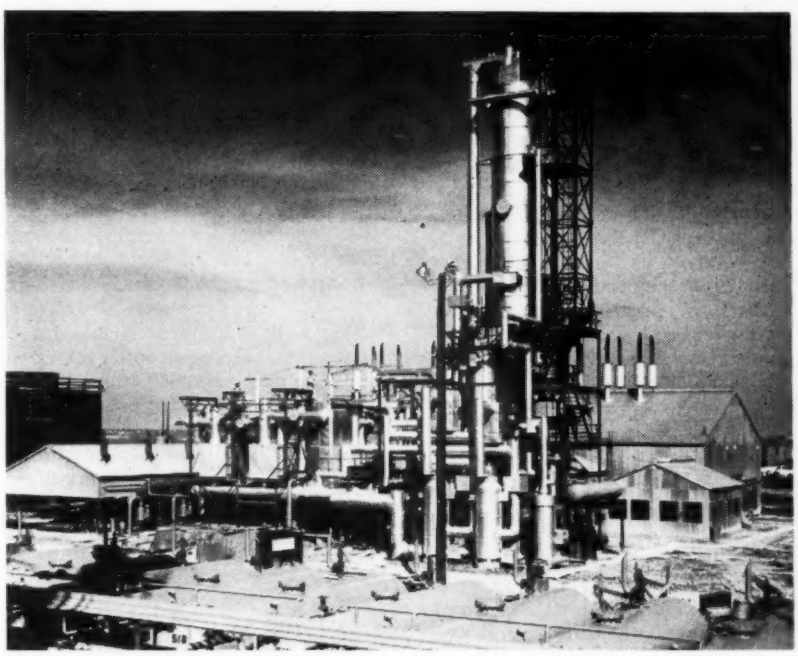
The oxygen manufactured at the McCarthy plant is delivered to the petrochemical units at approximately 800 psig., for the partial oxidation of methane to oxygenated products — methanol, acetaldehyde and formaldehyde.

Outstanding feature of the oxygen manufacturing installation is that it operates on a cycle that is entirely self-contained. Except for cooling water and a source of fuel gas, nothing is required for operation other than the air which is being processed. There is no need to maintain an inventory of chemicals or refrigerants. There is no problem of disposal of waste chemicals, and no danger of explosions or pollution of the atmosphere or nearby materials by refrigerants escaping from broken lines as a result of faulty operation. This self-contained feature is an assurance of continuous operation of the plant in any location.

Simply expressed, the production of oxygen from air is by liquefaction of air and fractionation of the liquefied air into two portions, of which one is principally oxygen and the other principally nitrogen. The process flow is such that the oxygen stream will also contain a portion of the carbon dioxide and water entering in the cooled compressed air. The diluents of the nitrogen stream are argon, oxygen, hydrogen and all of the low boiling rare gases, helium and neon. The oxygen content of the nitrogen stream depends on the oxygen recovery, which in turn, depends on the oxygen purity. When the oxygen purity is 95%, the nitrogen stream purity is also about 95%; increased oxygen purity results in lower nitrogen purity and lower oxygen purity in increased nitrogen purity.

Fractionation itself is normal and presents no unusual difficulties. The practical problems which occur are introduced by the fact that the liquefaction temperature of air at normal fractionating pressure is in the neighborhood of −300°F. This means that, before liquefaction, the air must be freed of those impurities which would be solid at the liquid air temperature. They would in time plug the lines and equipment. To produce oxygen economically, power and purifying costs must be low. Happily

This Month's Cover Picture



PETROLEUM PROCESSING *photo by Elwood M. Payne*

The first major low-pressure "tonnage" oxygen plant, which supplies 175 tons/day of 95% oxygen for the petrochemical operations of McCarthy Chemical Co. at Winnie, Texas. Shown in the photo, left to right, are atmospheric water cooling towers, circulating water pump house, exchanger area, oxygen fractionating towers (large column is low pressure tower, with high pressure tower behind it), air and oxygen compressor house, and (in front of the latter) instrument and control room

* Largest plant yet announced is the 2000-ton/day unit for Carthage Hydrocol's synthetic fuel plant at Brownsville, Texas, still under construction. Known oxygen plants for steel operations include a 400-ton/day plant which Air Products, Inc., is building for Weirton Steel Co. at Weirton, W. Va.; a 150-ton/day plant which Koppers Co. is building for Air Reduction Co. at Johnstown, Pa.; and a 135-ton/day plant which Linde Air Products Co. is erecting for Wheeling Steel Corp. Last June Linde Air Products Co. announced plans to build and operate a tonnage oxygen plant to supply oxygen to the Belle, W. Va. plant of E. I. duPont de Nemours and Co. Output, it was said, would be 360 tons a day of 95% oxygen. Construction was expected to be completed sometime in 1949.

these two requirements are not opposed.

Low power costs result from operation at comparatively low pressures and with extensive heat exchange between the air and products. Extensive heat exchange can also be used to purify the products. To operate at comparatively low pressures, refrigeration is obtained by the approximately isentropic expansion of a portion of the air through an expansion engine rather than the isenthalpic (adiabatic) expansion of the air through an expansion valve. Because the air does work when passing through the expansion engine, its initial pressure does not need to be as high for a definite temperature drop as it would be if it were expanded through a valve.

Major Gas Impurities

The major gaseous impurities in atmospheric air are water, carbon dioxide and hydrocarbons. These impurities can be practically completely removed as liquids or solids as the air is cooled but before it is liquefied. After the impurities have been precipitated, if the waste gas is warmed while passing through the same passage, the impurities will then be evaporated and removed from the system. This is the process occurring in the exchangers used to minimize power consumption. For a stated period, the air passes through one side of the exchanger, depositing water and carbon dioxide while being cooled by cold gas on the other side of the exchanger. At the end of the period, the air and cold gas reverse sides so that the impurities deposited in the first side will be evaporated. This reversal is continued indefinitely and automatically, thus permitting the continuous feeding of almost pure air to the fractionating equipment. Because of the alternation of sides, these are known as reversing exchangers.

Two complications enter into the simple picture presented of the reversing exchanger. The first is that air at high pressure has a slightly higher specific heat than that of the products at low pressure. This results in an increase in temperature difference as the air progresses from the warm end to the cold end of the exchanger. With a practicable temperature difference at the warm end (say 10° F.), the difference at the cold end is so great (20°-25° F.) that the cold gas cannot evaporate the precipitated impurities. The second complication is that the air to the expander must not only be free of impurities but must also be warm enough to avoid the liquefaction of air within the expander. Fortunately, there is a single solution to these two problems.

To allow for the higher specific heat of the air, a cycle stream is passed through the reversing exchanger in a separate non-reversing passage. The cold dry air to be fed to the expander is used as the cycle stream.

Consideration must also be given to air washing. High-voltage electrostatic cleaning is not satisfactory because it causes the formation of ozone. Water washing, therefore, is used. If the atmosphere is reasonably clean, the air is washed after compression, since the installation and operating costs are somewhat less there than at the compressor inlet and at least a portion of the air aftercooling can be done. However, if the atmospheric dust content is high, it is necessary to wash the air at the compressor inlet in order to protect the compressor.

The general method of operation may be described with reference to Fig. 1. Air is compressed to approximately 85 psig. and cooled with available cooling water. It then divides between the two reversing exchangers and is cooled almost to its dew point at the outlet pressure by indirect heat transfer to the products, oxygen and nitrogen. The reversal of sides is accomplished by a cycle timer controlling pneumatically-operated valves and thus is entirely automatic, requiring no attention by the operator. Reversal in flow on the downstream side of the exchangers is permitted by check valves designed for low-pressure drop.

Two-tower Fractionation

For maximum yield, the air is fractionated in a two-tower system consisting of a high-pressure tower and a low-pressure tower in series. After the reversing exchanger, the major portion of the air is further cooled by oxygen and nitrogen. It then enters the high-pressure fractionating tower and is separated into an overhead product of liquid nitrogen of almost 100% purity and a bottom product of liquid rich air, so-called because its oxygen content is 38-42%. The heat removal required to condense these two products results from reboiling in the low-pressure tower and evaporating the oxygen product with the gross overhead of nitrogen vapor. Part of this overhead, when condensed, returns to the high-pressure tower as reflux and part is net product. The rich air and net nitrogen liquid streams are fed to the low-pressure tower after being further cooled with product nitrogen.

The remaining portion of the cooled air provides the necessary refrigeration for the plant by the conversion of heat into work in a highly efficient centrifugal expander. Cooled air from the reversing exchangers is used for this air, and is practically free of water and carbon dioxide. To prevent the liquefaction of air within the expander, the cooled air is reheated before it enters the expander by passage through a separate non-reversing passage of the reversing exchanger. The expanded air enters the low-pressure tower as vapor.

In the low-pressure tower, the total air quantity is fractionated into a nitrogen-rich, overhead product and oxygen-rich, bottom product. In the product evaporator, almost all the product oxygen is evaporated; only a small amount remains as liquid to act as carrier for any hydrocarbons and permits their removal from the unit in a non-hazardous manner.

Both the nitrogen and oxygen product streams, after leaving the low-pressure tower, pass through the heat exchanger system, as indicated on the flow sheet, and leave the plant. The nitrogen leaves at atmospheric pressure; the oxygen leaves at 1.5 to 2.5 psig. This difference, resulting from the pressure drop through the low-pressure tower, is maintained primarily to prevent air leakage into the oxygen system.

Materials of Construction

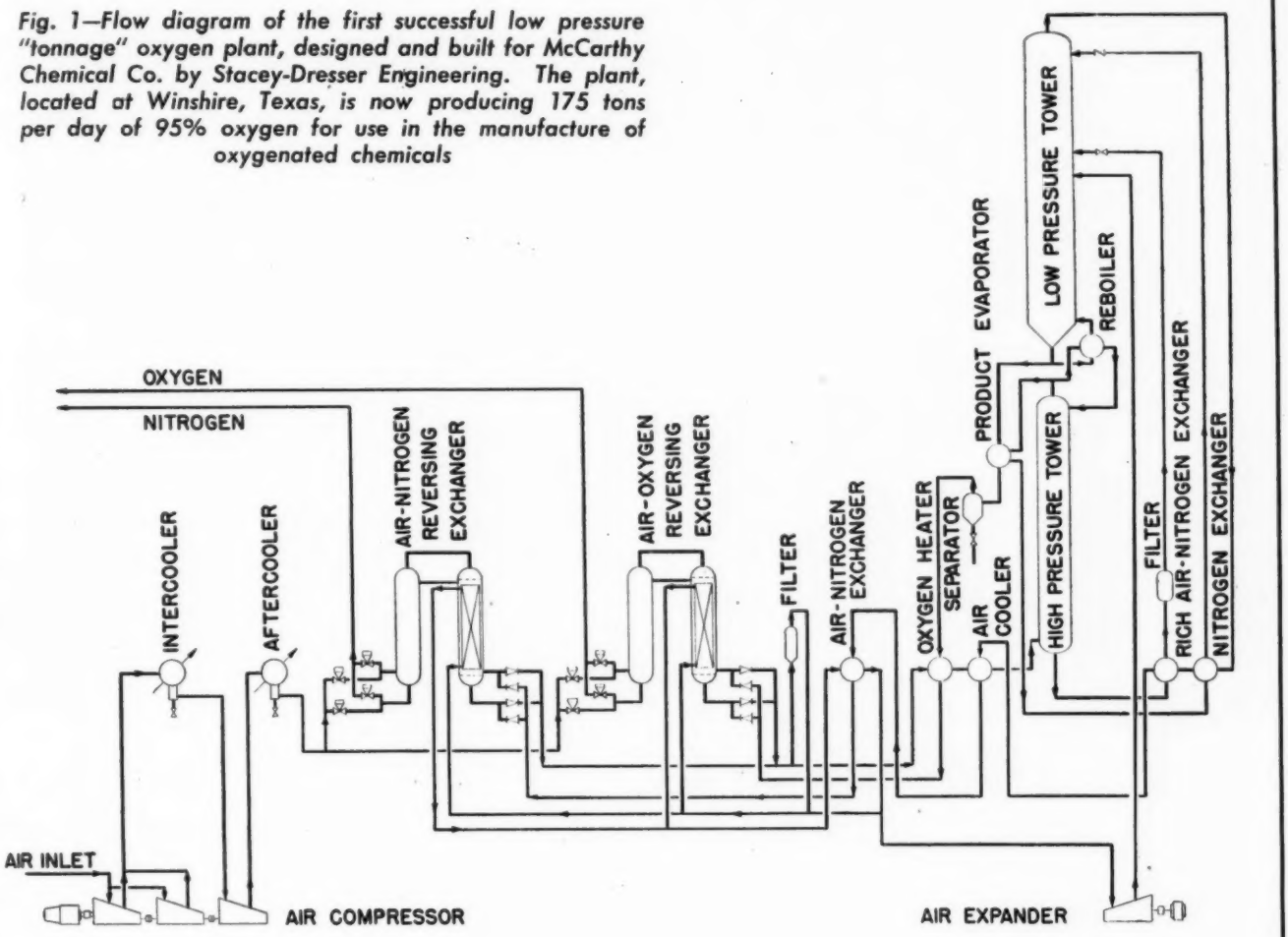
The material of construction selected for the low temperature area of the new McCarthy Chemical Co. plant has been aluminum. Based on studies made by Stacey-Dresser, it was determined that some of the aluminum alloys were not only capable of withstanding the extremely low temperatures (in the neighborhood of −300° F.) encountered in the process without becoming brittle, but also were more economical. Some of the stainless steels and bronze alloys, it is now known, can also be used at these sub-zero temperatures, but they are more expensive than the aluminum alloys. They have one advantage, however, and that is they are easier to fabricate, primarily because more is known about how to handle them. To overcome the fabrication angle, Stacey-Dresser developed a number of new techniques for both shop and field welding of aluminum which heretofore had not been done on an extensive scale.

Further studies are now being conducted to determine comparable costs for other suitable materials, and it is possible that later units will employ different materials in some of the low-temperature areas.

Many new problems were encountered in the development of the equipment required for this process of manufacturing oxygen. Although the low-temperature distillation of air has been carried on for many years, it has not been done in units of as large capacity as are now being considered.

Clark Bros. gas-engine driven reciprocating compressors were used to compress both the air and the oxygen

Fig. 1—Flow diagram of the first successful low pressure "tonnage" oxygen plant, designed and built for McCarthy Chemical Co. by Stacey-Dresser Engineering. The plant, located at Winshire, Texas, is now producing 175 tons per day of 95% oxygen for use in the manufacture of oxygenated chemicals



product. Since oil contamination could not be tolerated it was necessary to develop water-lubricated machines.

The reversing exchangers are probably the most important single item in the oxygen plant. Upon their proper functioning and continuous operation depends the economical operation of the plant. A unit has been developed which combines a large amount of surface in a small volume, is rugged and of comparatively low cost.

The unit consists of three concentric tubes with circular fins in the outer two annuli. Techniques have been developed for brazing the fins to all three tubes.

The highly efficient centrifugal expanders used in the McCarthy plant are a comparatively recent development of Clark Bros. In the earlier units heat was converted into work by means of reciprocating expanders which were of low efficiency. The operating cycle is such that low efficiency of the expander has a harmful effect on yields. Furthermore, the reciprocating expander required for this plant would be very bulky and expensive. The centrifugal unit not only increases the efficiency of the unit but also lowers the plant cost.

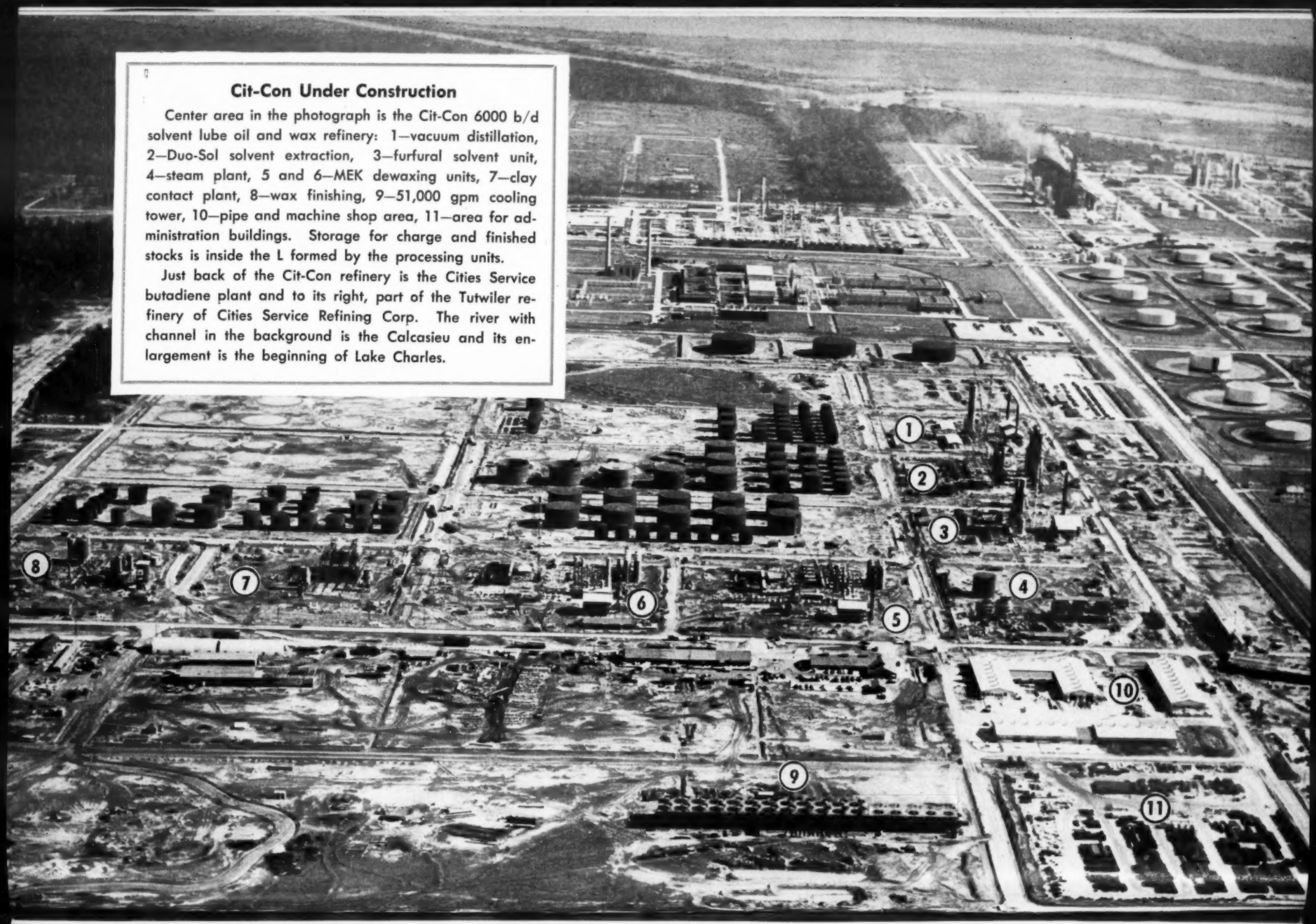
In addition, the centrifugal unit is far less subject to wear than the reciprocating, since there is no physical contact of the parts within the unit. Wear can occur only at the rotating shaft where it can be minimized by standard and well known uses of antifriction bearings. The centrifugal expander also has the advantage that the location of the cold and warm sections is static. This means that heat leak into the plant can be minimized comparatively easily.

The power generated by the expander is actually being used to pump cooling water. It is necessary to allow a fair margin of safety in determining the useful work which may be obtained because the expander duty will vary with the operating conditions of the plant.

The less special items of equipment required in the cold end of the unit are the exchangers and fractionating towers. The latter are essentially standard towers, usually provided with bubble cap decks. These decks are designed in accordance with the results of the latest studies on maximum efficiency and capacity. The design allows for the proper liquid and vapor quantities to be handled in order to obtain minimum pressure drop. This is extremely important since it has a direct effect on the power consumption of the unit.

The heat exchangers, except for those in normal service at the compressors, are specially designed by Stacey-Dresser Engineering to obtain maximum heat transfer rates with low-pressure drops. Although the arrangement of tubes and shapes of shells are not conventional, every effort has been made to restrict the component parts to standard items which may be obtained readily if replacement is required.

The materials used for insulating the cold area were Santocel, Fiberglas and Rockwool. Santocel is a silica gel material recently developed by Monsanto Chemical Company. The material has an extremely low bulk density and thermal conducticity.



Cit-Con Under Construction

Center area in the photograph is the Cit-Con 6000 b/d solvent lube oil and wax refinery: 1—vacuum distillation, 2—Duo-Sol solvent extraction, 3—furfural solvent unit, 4—steam plant, 5 and 6—MEK dewaxing units, 7—clay contact plant, 8—wax finishing, 9—51,000 gpm cooling tower, 10—pipe and machine shop area, 11—area for administration buildings. Storage for charge and finished stocks is inside the L formed by the processing units.

Just back of the Cit-Con refinery is the Cities Service butadiene plant and to its right, part of the Tutwiler refinery of Cities Service Refining Corp. The river with channel in the background is the Calcasieu and its enlargement is the beginning of Lake Charles.

Cit-Con

Engineered for Flexible Volume Lube Oil Output

By D. P. THORNTON, Jr.
Southwestern Editor

THE LATEST WORD in modern lubricating oil refineries is rising from a 360-acre tract in the heart of a pine forest about 12 miles from Lake Charles in southwest Louisiana. It is owned by Cit-Con Oil Corp., which was formed by Cities Service Co. and Continental Oil Co. for the purpose of building and operating the plant. Its top supervisory personnel will be drawn equally from these two organizations.

The plant's production of finished stocks will be divided between the two companies. Continental will receive 35% for disposal through its marketing outlets, with the balance going to Cities Service. Cit-Con will not maintain a sales organization of its own or independently make outside sales.

The plant, said to cost $40,000,000, was in the latter stages of construction when visited by the writer recently. When finished, it will be capable of producing 6000 b/d of high-quality solvent refined lubricating oils and more than 1500 b/d of fully refined paraffin and microcrystalline waxes. It will employ 642 people. Completion is scheduled for 1949.

Design and construction of the refinery is by the Lummus Engineering Co., with the exception of the Duo-Sol plant, by Max B. Miller Co. Walker & Poor Co., architects, designed the office and change house. The various units are listed in Table 1 with charge capacities and products made.

Many engineering innovations are incorporated into the design of almost every unit, as a result of advances in refining technology, the unusual size of some of the facilities, and because of the rigid quality tolerances which have been set for the products. This article is confined to a discussion of these departures from conventional design, since the fundamental principles of the processes to be used are well known in the industry.

The first unusual feature of the Cit-Con lube oil refinery is that no facilities are provided for crude distillation or disposal of by-products. For these, Cit-Con is entirely dependent on the adjacent Tutwiler refinery of Cities Service Refining Corp. Topped crude is supplied from this refinery from a blend of sweet crudes from East Texas, North and South Louisiana and Arkansas.

By-products sent from Cit-Con to Cities Service for use or disposal include gas oil; excess 100 viscosity waxy neutral distillate, to be blended into catalytic cracking charge stock; solvent refining extracts, which will be blended with cycle gas oil (from Cities Service) to No. 6 fuel specifications; unmarketable wax fractions, also slated for cracking stock; and acid sludge, to be processed for acid recovery. Provisions for disposal of contact clay have not been settled as this article is written.

On the process side, the twin vacuum units will produce close-cut lube distillate fractions which will not require re-running for viscosity control. The furfural extraction unit is the largest ever built and carries many late technical improvements. The Duo-Sol plant, also a world's largest, has improved solvent recovery facilities.

The two MEK plants are designed to dewax, respectively, light distillates, and 500 neutral distillate and bright stock. The plant for light distillates has recrystallization facilities and later may be equipped for incremental dilution, while the other is designed for addition of the recrystallization feature in the future. However it is presently equipped with re-pulping facilities to reduce oil content of the amorphous type wax. Allowances also have been made for expansion of numerous facilities should the need develop.

Vacuum Distillation Units

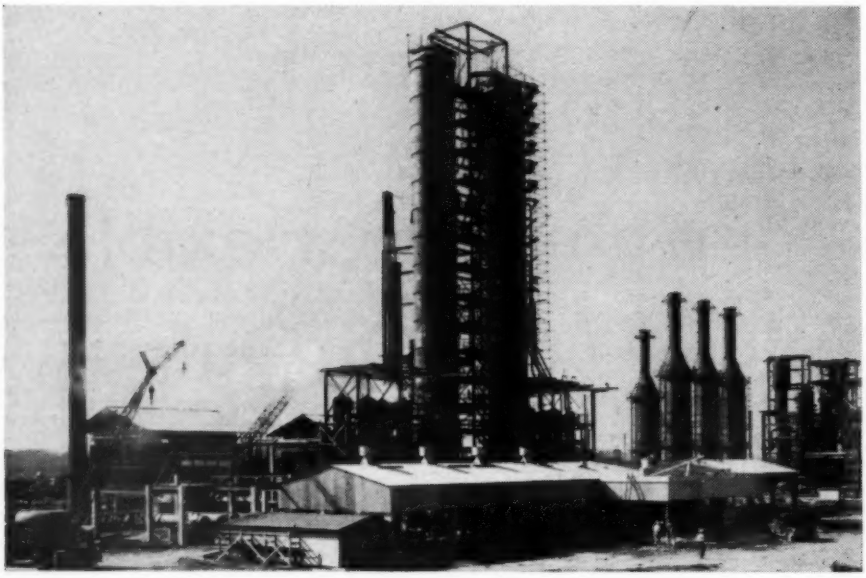
Engineering design of the Cit-Con plant was commenced in 1946 and based on a "prototype" crude, which was a blend of available crudes in proportion to supply. Continental Oil provided reduced crude for extensive pilot plant studies by topping a batch of the blended crudes in a commercial crude distillation unit.

These studies indicated that, for production of finished lube oil totaling 6000 b/d, 18,852 b/d of the

TABLE 1—Units of the Cit-Con Refinery, Capacity and Products

Unit	Charge Capacity B/D	Products Made
Vacuum Distillation (2)	12,500 each	100, 200, 300, 500 neutral distillates, residuum
Duo-Sol	9700	Part of 500 neutral & all bright stock raffinates
Furfural	*6400 to 11,000	100, 200, 300 & part of 500 neutral raffinates distillates
No. 1 MEK Dewaxing	*4300 to 4800	100, 200, 300, 0° pt. neutrals & crude paraffin wax
No. 2 MEK Dewaxing	4240	0° pt. 500 neutral, 0° pt. 150-160 bright stock, waxes & petrolatum
Clay Contact No. 1	*3090 to 3650	Finished 100, 200 & 300 neutral oils
Clay Contact No. 2	*2740 to 3180	Finished 500 neutral oil & 150-160 vis. bright stock
Wax Finishing	1000	Finished 120°, 130° & 140° m.p. fully refined wax
Wax Slabbing	....	10 lb. paraffin wax slabs
Laboratory	....	
Steam Plant	375,000 lbs./hr.	
Shops, etc.	....	

* Depending on particular stock charged.



Vacuum distillation area showing, left to right, heaters, vacuum towers and strippers (behind pumphouse). Duo-Sol unit is in right background

topped "prototype" crude must be charged to vacuum distillation. In actual operation it is expected the blend of crudes will vary considerably from the "prototype" blend. For flexibility and continuity of operation it was decided to erect twin vacuum units with some overcapacity to permit producing a higher proportion of neutral oils to bright stock when required. Consequently, each unit will handle 12,500 b/d of reduced crude.

Because of the possibility for stratification of the various types of reduced crude in the charge tanks, special arrangements have been made to assure a uniform charge stock in each tank. Three 80,000-bbl. tanks will be used for this service, each equipped with two 25-hp. propellor-type "Lightning" agitators to mix thoroughly the tank contents. Each tank will supply total charge for nearly four days, which simplifies operation and improves quality control.

Gas oil containing no desired lubricating oil fractions will be condensed in the top five trays of the tower by a gas oil reflux—the only overhead material is stripping steam. Gas oil constituting overhead make as well as reflux actually is a side-draw product. Gas oil reflux will be drawn from the fifth tray, cooled and returned to the two top trays. Gas oil make will be drawn from the top tray. Four cuts will be withdrawn at lower points and passed through strippers. Three of these are to be reboiled by exchange with tower bottoms, producing high flash fractions of the proper viscosity for further refining without additional viscosity control through further fractionation.

Bright stock produced from the residuum will have a Saybolt Universal viscosity at 210° F of 150-160 seconds. The viscosities of the three distillate streams will be regulated to produce finished lube oil viscosities of 100, 200 and 300-350 SSU at 100° F. and the bottoms likewise controlled. The fourth, or heaviest, distillate stream, while nominally producing approximately a 500 neutral oil when refined, necessarily will have whatever viscosity it "accidentally is," since it will contain the rejects resulting from rigidly controlling the viscosities of the 300 neutral and residuum streams.

Each unit will have a fractionator column 114 x 13 ft., equipped with Lummus designed "shower" trays instead of the conventional bubble decks. Exceptions are the top tray, the two trays above the charge inlet and several in the residuum stripping section, all of which will be bubble decks. This design is said to permit a smaller diameter tower and reduce overall pressure drop, the latter especially important when tower products are to be closely fractionated sidestreams.

As the name implies, the so-called "shower" tray divides the descending reflux into thousands of small streams through which the upcoming vapors must pass. The tray itself has a large liquid area and a perforated area. A weir maintains a depth of liquid on the liquid area and also serves to distribute the overflow uniformly onto the perforated section. The balance of the tray area is open for ascending vapors. The number of perforations is greatest at the top of the tower and decreases toward the bottom, due to the difference in internal reflux at different points.

Several advantages are reported for this type of tray. In addition to a lower pressure drop and reduction in tray area for a given charge rate, a substantially increased vapor velocity, compared to bubble decks, is possible without danger of flooding. This design suffers from having a somewhat lower tray efficiency than the usual bubble tray, however.

Another interesting feature of these units is the use of an oil separation tank to minimize oil losses in case a small amount of gas oil is carried overhead. Stripping steam overhead is totally condensed by water cooled surface condensers and then condensate is dropped to the sewer after the small quantity of gas oil contaminating it is separated. The separated gas oil is combined with the make gas oil and pumped to storage.

Final control of flash specifications of distillate side streams is achieved in the strippers. Here steam is injected, with reboil heat being supplied by exchange with tower bottoms to all except the 500 neutral stream which is not reboiled. Overhead vapors are returned to the vacuum tower above the respective side-draw points.

Another slight departure from the conventional is the injection of a part of the stripping steam into the reduced crude charge in the radiant section of the Lummus box-type heater, charge preheat being achieved by exchange with all side and bottoms streams. Steam superheating is done in this heater, also.

Both units are identical, though entirely separate except for a common control room. Laboratory samples for flash and viscosity will be taken every four hours.

Furfural Extraction Unit

The furfural unit is entirely conventional in basic design, but several refinements have been made in this installation. In order to permit the same charge rate for both 95 and 100 V.I. operation, the solvent circulation rate has been set at 30,000 b/d and recovery equipment designed accordingly. Principal, although not entirely new, improvements over some earlier plants include the use of flue gas blanketing of solvent storage tanks, the incorporation of charge de-aeration under 1.5 psia. pressure to reduce oxygen and consequently minimize decomposition of furfural with the formation of corrosive acids and coke, and revisions in the venting system to prevent air intrusion.

Four stages of solvent recovery are used on the extract phase, in comparison to three as in some units. The first stage involves vaporization of the extract phase under atmospheric pressure in a column, where

approximately one third of the furfural is taken overhead. The bottoms then are heated before passing to a pressure flash tower, where most of the remaining solvent is recovered, then through another heater to a vacuum flash tower, where all but a small amount of the remaining furfural is recovered. A final stripping with steam removes all but trace amounts. So large is the volume of solvent handled that a heater absorbing 72,000,000 Btu. per hour is required to evaporate solvent in the charge to the pressure flash chamber, for example.

Solvent recovery from the raffinate is much simpler because of the smaller quantity. Processing sequence here includes heating in a furnace, followed by vacuum flashing and, finally, steam stripping under vacuum.

Duo-Sol Refining

Solvent refining of vacuum tower residuum and also a part of the heavy distillate stock (to balance throughput requirements) will be handled in the Duo-Sol unit. It is largely conventional, despite the large size, except in the recovery section.

The changes include increasing the pressure of the Selecto recovery towers to 70 psi. to supply reboiler heat to the propane recovery section, operation of raffinate and extract stripping towers under vacuum to decrease solvent loss and use of a Selecto solvent containing 80% phenol and 20% cresylic acid to produce a higher miscibility temperature between extract and raffinate layers. The novel vapor relief system is also of interest.

The solvent extractor section will have seven extractors 90 ft. long and varying in diameter from 6.5 to 10 ft., each with a separate circulating pump, except No. 1 extractor. Initial charge requirements of solvent for the system are 3900 bbls. of Selecto and 5000 bbls. of propane.

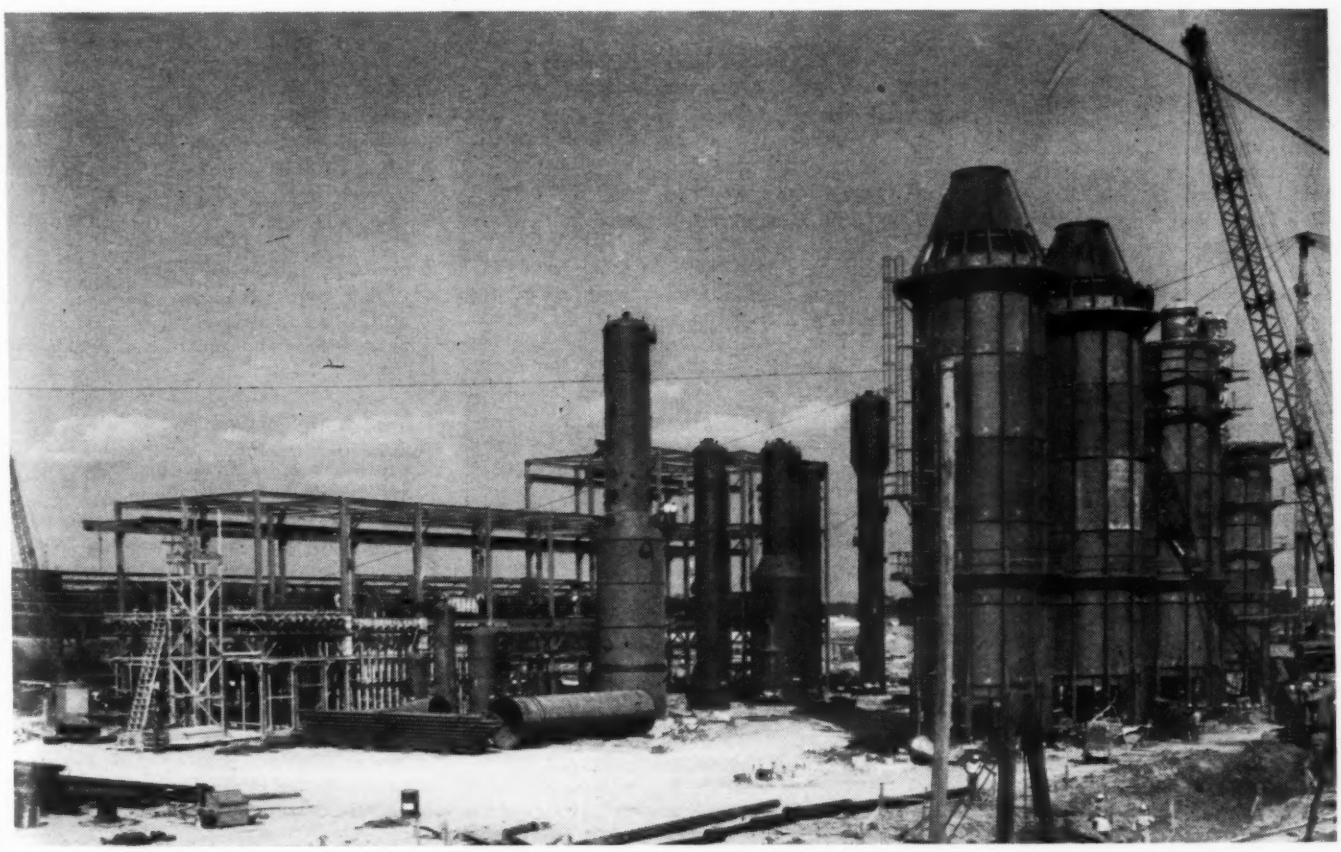
The extraction section is entirely conventional except for the use of more phenol in the Selecto to increase miscibility temperatures. This is primarily for improving operation by minimizing the chance of extract and raffinate layers becoming miscible in summertime. The cooling water temperature then may increase sufficiently to make difficult a clean separation between raffinate and extract if the usual (lower) phenol concentration was used. This modification also permits a higher extractor temperature which may improve results when refining difficult stocks.

The extraction section recovery system will be more complicated than in the usual Duo-Sol unit, largely because of the large volume of solvent to be handled. Following the extract phase through the recovery system, it enters the first tower at 245 psig. for propane recovery, reboiler heat being supplied by exchange with Selecto vapors at 70 psig.

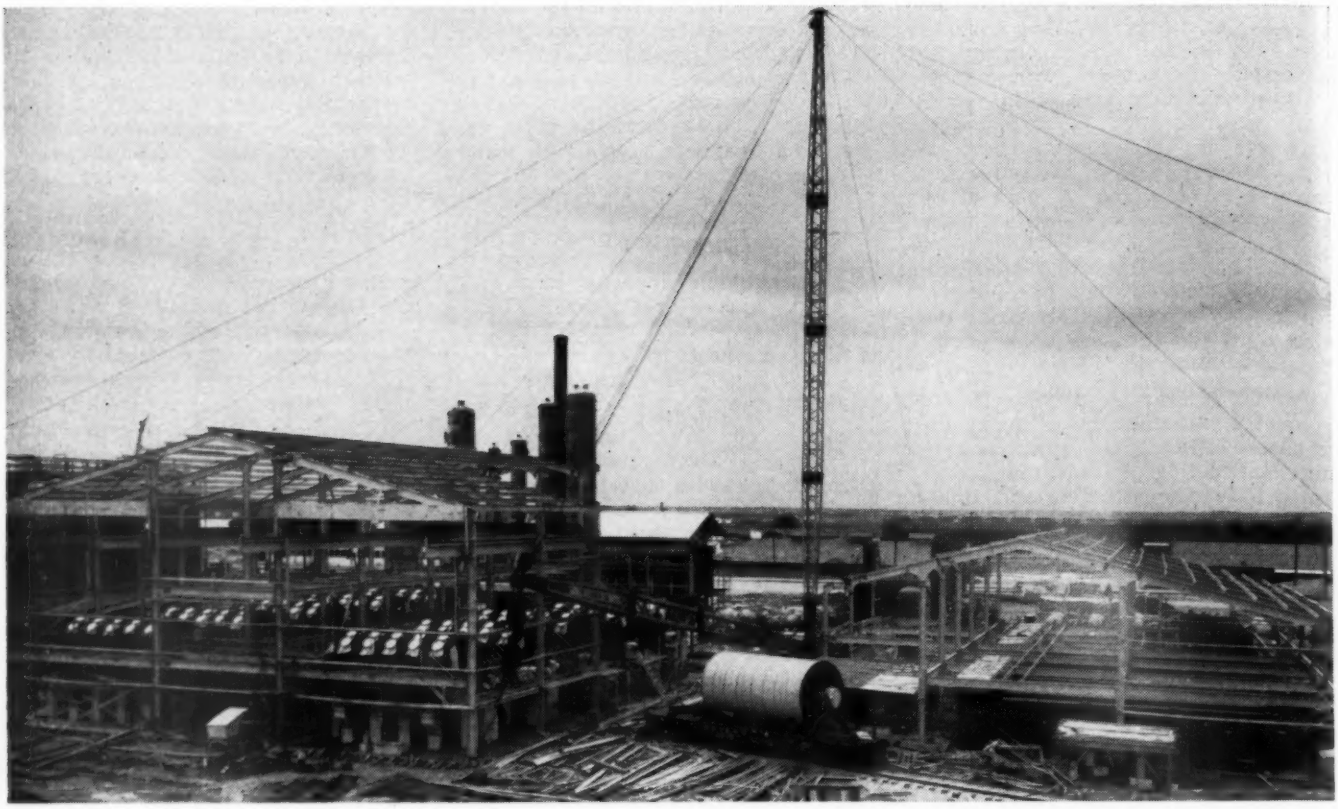
Bottoms from the first tower are charged to a second, where the remaining propane vapors and part of the Selecto are flashed off at 70 psi. The liquid, containing extract, and the remaining Selecto drops by gravity into the second Selecto recovery tower which also operates at 70 psig.

This tower is reboiled by circulating the bottoms through three Petrochem heaters. The Selecto vapors are used to reboil the liquid from the bottom of the extract high pressure propane recovery tower and also to reboil the liquid from the bottom of the raffinate high pressure propane recovery tower. This eliminates two heaters usually used. Bottoms then are steam stripped in a tower operating at 70 psi. and finally steam stripped under vacuum.

The raffinate solvent recovery system is quite similar, the propane recovery tower being reboiled with flashed Selecto from the extract re-



View of the Duo-Sol unit showing, left to right, some of the extractors, electrical buildings and pumphouse, part of the fractionation equipment and heaters under erection



The No. 2 MEK dewaxing plant. Ten filters are installed in the filter house at the left, 6 for dewaxing, four for de-oiling following the repulping step. The filter building was left partly unroofed to expedite installing heavy equipment by crane. Solvent recovery towers are behind the filter house, part of the heater is visible in center background. Chillers will be located in building at right

covery tower, as previously mentioned, followed by one instead of two stages of flashing at 70 psi. with heat supplied by a Petrochem furnace; one stage of steam stripping at 70 psi., and finally vacuum stripping. This recovery system handles more propane but less Selecto than the extract recovery system due to the different concentration of the two solvents in the extract and raffinate phases.

All the Selecto recovered from extract and raffinate phases in both liquid and vapor phases is charged to a drying tower for removal of water and propane. Here it is condensed by Selecto and water reflux, leaving water vapor, propane and some Selecto as the overhead. Water and Selecto are next condensed, the propane remaining as vapors being recompressed for storage. The Selecto-water mixture is pumped to a tank to be settled, the Selecto-saturated water phase being subsequently treated with sodium sulfite for removal of dissolved oxygen and then pumped through the propane storage tank where most of the remaining Selecto is scrubbed out. The water-saturated Selecto is returned to the Selecto drying tower.

The water remains in the system, being used to supply all stripping steam required in the unit. The water, after passing through the propane tank, is next passed through a stripper in which some steam is used to further strip Selecto from the water stream. Steam from the top of this stripper, now more contaminated with Selecto, is next superheated in a furnace and used to operate the steam vacuum-jets and also for stripping in the 70 psi. strippers.

The stripped water flows by gravity into the steam drum, where it is converted to steam by exchange with the raffinate and extract oil streams. Steam produced is divided into two streams, one stripping incoming feedwater of Selecto; the other for superheating and use in the vacuum strippers.

The reason for this complicated procedure is to minimize the content of Selecto in the steam used for final stripping of raffinate and extract, thereby insuring maximum recovery of Selecto from these streams. Also, because of its Selecto content and unnecessary expense of purification, it is not desirable to dispose of the water to plant sewage.

Steps have been taken to provide an adequate pressure relief system for the Duo-Sol unit from the several important standpoints of employee safety, protection of equipment and loss of Selecto solvent. There are two, the so-called "high-" and "low-pressure" relief systems.

The high pressure system handles liquid and vapor from the relief valves on the extractors, propane storage tanks and the propane recovery towers, all of which discharge into a common header which leads to a liquid trap. This, in turn, is vented to a flare, as the vapor would largely consist of propane.

Not so simple is the "low-pressure" system, which must handle Selecto vapor from the Selecto recovery towers for the most part with propane contamination probable. Relief valves on these towers vent into a common header which discharges into the Selecto-water settling tank underneath the water level. This will permit condensing most of the Selecto vapors involved and simplifying their return to the system.

This vessel is sufficiently large to absorb a considerable surge. It is believed that the separator could relieve simultaneously all of the unit's towers long enough to permit re-

gaining control of the upset towers without losing a great amount of Selecto. However, just in case, the separator also is vented to a nearby stack, equipped with a cold water spray to knock down any Selecto vapors which might get by the separator.

MEK Dewaxing

The MEK solvent dewaxing process is used following solvent refining of all raffinate stocks. The decision to dewax after solvent refining is based on these factors: (1) The produced wax contains a higher quality oil if first solvent refined, which simplifies the job of treating the wax to the "fully refined" state, (2) It is less expensive to dewax after solvent refining. Otherwise, larger quantities of material must be handled and dewaxing must be performed at a lower temperature to obtain the desired pour point, due to concentrating the remaining wax in the raffinate by solvent treating.

Two separate dewaxing plants are being constructed. One will dewax the three lightest distillate stocks, the other will handle the heavy distillate and bright stock fractions. They will be approximately equal in solvent circulation capacity and conventional in design insofar as oil chilling, filtering and solvent recovery are concerned. Due to their large capacity and, consequently, large refrigeration requirements, a central propane refrigeration system will be used.

Refrigeration will be supplied by three 3600-hp. Worthington centrifugal compressors, one a standby, carrying a normal total load of 2300 tons. Compressors will be steam turbine driven at 5000 rpm with 650 psi. steam. Suction pressure will be 5 psi., discharge 230 psi. following four stages of compression, each compressor will handle 1593 lbs. of propane per minute.

Two of the turbines will exhaust at 250 psi. to furnish steam for other plant uses, while the third exhausts to a vacuum condenser and returns condensate to the boiler house. Due to the large size of the installation, substantial savings in the first cost, space and anticipated maintenance will be achieved through the use of centrifugal rather than reciprocating compressors.

A flue gas system also is used to supply inert gas for blanketing tanks, filters and the like at both MEK plants, and also to supply flue gas to the furfural extraction unit and the clay contact plants. A conventional Kemp generator, using natural gas as fuel, supplies this material from its central location at No. 1 MEK plant.

No. 1 MEK, handling light distillates, is distinguished by having a recrystallization system and is designed to permit modification for incremental dilution at some future date. Dewaxing temperature is —15° F. to make a zero pour test oil. Four G.A.T.X. vacuum filters, 10 ft. in diameter by 20 ft. long, blanketed with flue gas and providing 625 sq. ft. of filtering surface each, are used to remove the wax.

Wax from the first filtration is remixed with solvent, heated to 120° F and rechilled to 25° F. Again refiltered, the "soft" wax and oil go into the filtrate and the product wax is filtered out as a cake. Three solvent recovery systems, all conventional in design, are used to process the oil, recrystallized wax and soft wax streams.

No. 2 MEK, handling the 500 distillate and bright stock, has six primary filters instead of the four at No. 1. The processing to this point is similar to that previously described. Instead of recrystallizing, however, this plant slurries (repulps) the primary wax with additional solvent and refilters (four filters are available) at —15° F for de-oiling to a maximum of 5% in producing microcrystalline wax. The filtrate, oil-solvent mixture, is returned to the primary filter charge stream for recovery of the oil. There are only two solvent recovery systems in this unit, one for oil and one for wax, and provisions have been made for later modification to wax recrystallization, if desired.

Oil and Wax Finishing

Clay treatment of all dewaxed oils will be used to achieve improved color and stability, in two identical plants. One will handle light distillates; the other heavy distillates and bright stocks, respectively. One will be described.

The clay will be stored in two 225-ton hoppers, being handled to and from storage by air conveyors. The clay will be added to the oil by means of a Syntron feeder, after which the mixture will be heated to 330 to 530° F., depending on the stock. In the contact tank, level control will be used to maintain desired contact time.

Leaving the contactor, oil flows to a filter after being cooled to 265 to 440° F., again depending on stock. Oliver "Precoat" filters each have 400 sq. ft. of surface and are blanketed with flue gas because of the high temperatures. Clay from the filter is dumped to a slurry tank for disposal.

The filtered oil then is twice vacuum stripped, once at 100 mm. Hg. abs. and finally at 20 mm. Hg. abs. for final removal of traces of odor, light hydrocarbons, solvent and water. A blotter press removes any traces of remaining clay before the finished oil is pumped to storage.

Only crystalline paraffin waxes will be treated in the wax finishing plant. The 120, 130 and 140 m.p. waxes will be treated first with sulfuric acid in two 800-bbl. batch agitators. Washing with dilute caustic for neutralization of remaining acid follows in two additional agitators, then washing with water, and drying in a vacuum dehydrator to remove water and traces of odor. Intermediate storage ahead of final percolation through bauxite is insulated and equipped with hot water coils to hold the proper temperature and minimize danger of oxidation.

A novel means is used to dispose of the acid sludge resulting from acid treatment. Usually this is one of the suppressed headaches many refiners have, but Cit-Con will dump this molten material into an insulated trailer equipped with steam coils when re-heating becomes necessary. When the trailer is full, it will be hauled to the nearby Cities Service refinery where the material will be blended with spent alkylation sulfuric acid and charged to their sulfuric acid plant. The quantity of sludge will vary between 25 and 50 b/d.

Treated wax is percolated through 10 by 60 ft. filters, of which four are provided, holding 60 tons each of "Porocel" brand of bauxite. These discharge to "run tanks," which are lab sampled and tested every eight hours, and thence to insulated and heated 2500 bbl. storage tanks. Wax is transferred from these directly to tank cars, or to the slabbing building, to be made into 10 lb. slabs for shipment in cartons or loose. There are six Bethlehem moulds in the building, each producing 240 slabs. In the wax warehouse, in the same building, use of palletizing and lift trucks is planned. The building may eventually be summer air-conditioned if difficulty is experienced with slab warpage.

Percolation clay will be regenerated in a Pacific Foundry Co. multiple hearth type kiln. Prior to burning, however, the wax will be washed from the clay with steam-heated naphtha, recovered in a batch still and returned to process.

An interesting point about the wax finishing section is the minimum of storage provided for finished fully-refined wax. Due to the rigid specification requirements for these products and their tendency to oxidize on long storage in the molten state Cit-Con will hold the bulk of its wax production in the "unfinished" stage. Finishing will be done only as shipping orders dictate.

"Off-Battery" Facilities

Extensive storage facilities are required in the Cit-Con plant, which is designed to run in "blocked" operation on all units except the vacuum distillation units. Since the plant

also is designed for precise control of processing and protection of high product quality, a considerable amount of "run-down" storage is necessary. Run tanks for the vacuum distillation units are a case in point, which can be repeated for all other units in the plant. All told, there are 130 storage tanks with total capacity of approximately 1,800,000 bbls.

As stated earlier, three-80,000 bbl. topped crude storage tanks are provided, equipped with agitators for maintaining a homogeneous charge. In addition there are four 2500-bbl. "run" tanks for each of the distillate oils, four 5000-bbl. tanks for vacuum residuum plus a 5000 bbl. "slop" tank, and three 5000-bbl. gas oil run tanks. Likewise there are three 25,000-bbl. residuum storage tanks plus two-10,000 bbl. residuum charge tanks for the Duo-Sol unit. Plant product storage is shown in Table 2.

At every unit, daily production will be collected in a single tank, sampled and tested before being run to intermediate product storage. This assures not only precise quality control but reduces the possibility of throwing a large intermediate tank off test.

All finished lube oil storage tanks are "air-conditioned." Air is supplied to each tank from a battery of Pittsburgh Electro-Dryer Co. automatically regenerated activated alumina dryers. This air enters at the top and may flow at the maximum rate of 150 cfm. when the tank is being pumped out. Exiting at the other side, this partially dried air positively prevents tank "breathing," and eliminates moisture condensation which could "cloud" the oil. For prevention of stratification and accuracy in sampling, these tanks also are supplied with agitators.

Five 10,000 bbl. storage tanks are located at the docks for additional storage and to permit pumping out barges if the oil should be contaminated after loading. This transfer system presented one of the difficult engineering problems in the plant design, according to Cit-Con engineers, in order to work out a means to protect product quality without an excessively complicated and expensive transfer line system. The plant also is equipped to blend oils viscosity-wise for tank car shipments. Since this is a base oil plant, however, no facilities are available to incorporate additives into the blend.

Contaminated oil can be returned through the transfer lines to the plant, where a vacuum dehydration unit has been installed to heat the oil to approximately 200° F. and spill it over trays in a column where a 26-in. Hg. vacuum is maintained. This unit also is available to handle finished oil from the main storage tanks in case of accidental moisture contamination.

Transfer of oil from storage tanks to vessels at the dock will be through four 8 in. diameter lines two miles long. The lines will be designed for the use of a close fitting disc type separator to completely separate different V.I. grades when changing to a different grade. This device, which is similar to internal scrapers used on crude oil lines, also will be used to clear the line of oil when necessary by pushing it through with air pressure. Facilities also will be provided to wash the line with the grade of oil to be loaded, when necessary. Due to the large line volumes involved, however, this must be kept to a minimum to prevent accumulation of large volumes of off-test oil. The design provisions discussed will make possible maximum protection of oil quality and will insure efficient large volume handling of products meeting close specification requirements.

Other items of interest in the off-battery facilities, aside from the steam and water cooling plants, include a dual-sewer arrangement for waste disposal, transfer of by-products to Cities Service for disposal and general utility lines.

The two sewer systems handle, respectively, surface drain-off and oily waste. Surface water is collected by the usual system of ditches and enters a large holding pond. This, in turn, discharges into a nearby stream through weirs which will hold back any incidental oil which may collect. The oily waste likewise is collected in the conventional manner, but discharges into an API-design oil separator. Clean, uncontaminated effluent from this separator also is discharged into a nearby stream.

All produced gas oil, excess waxy distillates and by-product waxes are collected in a single large tank provided with steam coils and agitators, and there blended for transfer through a single line to the Cities Service refinery. Extracts from the Duo-Sol unit will be blended in a separate tank with special cycle gas oil, furnished by Cities Service, into a No. 6 fuel oil; furfural unit extract will be pumped from a special tank into another line ending in the Cities Service refinery, as it may be used either as a cracking stock or blended to heavy fuel oil.

TABLE 2—Finished Product Oil Storage at Cit-Con Plant

Product	Capacity, bbls.
100 Neutral	2-25,000
200 Neutral	2-55,000
300 Neutral	2-25,000
500 Neutral	2-25,000
Bright stock	2-55,000
"Spare" tankage	2-25,000

Laboratory

The laboratory will be housed in four buildings, and equipped for routine control tests as well as a certain amount of experimental investigation. The main building will house administrative and clerical personnel along one side. The major area of the building will be divided into two rooms for routine control tests, dispatcher and sampler's room, stock room and the like. At the other end will be a small experimental furfural unit. Also located here will be facilities for experimental clay contacting and wax percolation.

The first of the three smaller buildings, located at one end of the large building, will be devoted to utilities serving the laboratory including vacuum and compressed air systems and refrigeration compressors. Refrigeration will be supplied to the various installations requiring it from a central brine tank and circulating pump. Shipment samples and experimental samples retain storage is in this building also.

The second small building is intended to house two batch experimental vacuum stills, small batch deasphalting equipment and the like. Also there will be a very simple batch MEK dewaxing unit, sufficient to permit special studies of dewaxing problems but not the expensive type of continuous pilot unit for duplicating plant operations.

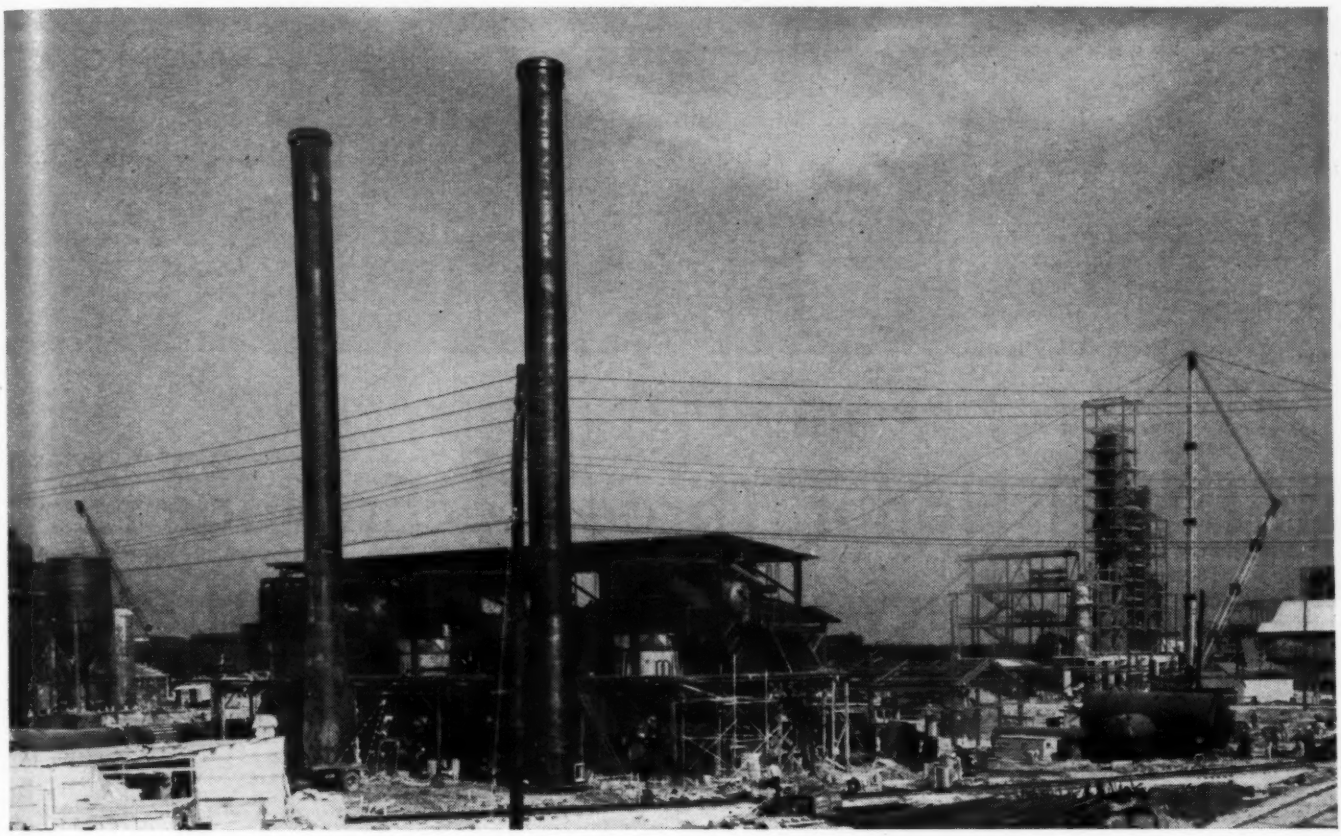
The third building will be reserved for empty container and supply storage, and also will include a bottle wash room.

Steam and Water Facilities

The Cities Service plant will supply electric power to the Cit-Con refinery. All but reciprocating pumps are electrically driven. Most spares are steam turbine drive.

Three 125,000 lb. per hour boilers being built by Combustion Engineering Co. will supply 650 psig. steam superheated to 750° F. There are in effect four separate steam systems, of which the 650 psig. system is one. This supplies the centrifugal compressors at the MEK plants and three of the six circulating water pumps, which are designed to exhaust at 250 psig. to supply the second, or normal 200 psig. system. The 200-lb. system supplies power for the reciprocating and turbine-driven pumps in the process areas and these prime movers, in turn, exhaust to either a "clean" 15 psig. system or an "oily" 12 psig. system.

The "clean" 15 psig. system, supplied from the steam turbines, does not contain oil and therefore may be used for process stripping operations and to heat the various buildings. The oily 12 psig. steam coming from the reciprocating pump discharges is used in the steam coils



Boilers of the steam generating plant. Water treating and related facilities are at the left, part of the furfural unit at right

in tanks. In the event that prime movers do not supply enough 200-lb. steam, provisions are available to de-superheat the needed quantity from the 650 psig. system.

In normal operations, the only condensate returned to the boiler plant is some 200-psig. steam from the MEK and Duo-Sol plants. The balance of the condensate is discarded to the oily sewer. Studies will be made in the future to determine the feasibility of cleaning up this oily condensate, but it is anticipated the expense of collecting and purifying it will be quite large.

The water system is closely associated with the boiler plant and, indeed, much of it is located at or near the boiler plant and handled by its personnel. The treating system is designed to supply 100% of boiler feed water makeup when necessary. Well water supply comes from two 700-ft. wells and one 500-ft. well, all good for 1500 gpm. each.

Boiler feedwater treating is all external in two stages. The first step is a conventional hot lime-soda treater using dolomitic lime and soda ash. Magnesium oxide will be added when needed for further silica reduction. The effluent is free of magnesium, bicarbonates, and most of the calcium and silicon. The second stage treats the water with disodium phosphate to precipitate the balance of the calcium. Effluent is filtered through Anthracil filters, sulfuric acid treated for pH control, de-aerated and, if necessary, sodium sulfite will be added for further oxygen control.

Circulating cooling water will be treated with sulfuric acid for pH control and probably antiprecipitants and corrosion inhibitors will be used. Chlorination will be utilized to control microbiological growths. Make-up water for the circulating water system will come from the well. Potable water supply is to be chlorinated only.

Dominating the cooling water system will be a single Water Cooling Equipment Co. (St. Louis) tower rated to cool 51,000 gpm. from 117° F. to 92° F., based on a 95° F. dry and 87° F. wet bulb condition. It is 409 ft. long, 49 ft. wide and 24 ft. high, of induced draft design; contains 34 cells. Draft is provided by 14-ft. diameter stainless steel clad adjustable pitch blades, driven by 40-hp. motors through a reduction gear.

Each of the tower cells has three rectangular grids, or beds, arranged stepwise over the cell height. Water enters at the top of the cell, falls through the first bed, is collected, falls through the second and, similarly, the third bed. Fresh outside air, however, is supplied to each bed, so that in effect the water is contacted three times with fresh outside air. Cells are so arranged that two can be shut off and, through a walkway provided down the center of the tower, workmen can enter any pair for maintenance or inspection without shutting down the entire tower.

From the tower basin, water flows by gravity through a 6-ft. diameter concrete line 700 ft. long to the boiler plant, where six 8500 gpm. circulating water pumps are located. Three of these are steam and three are electric driven. Water flows to the process area through underground coated steel lines and thence to the cooling tower. Plant cooling water design requirements actually are 48,000 gpm.

Acknowledgment

The author gratefully acknowledges the co-operation of F. M. Simpson, vice-president and general manager, and L. D. Grubb, chief process engineer, Cit-Con Corp., in the preparation of this article. Their suggestions and criticisms of the finished manuscript were most valuable.

Mr. Samans

Dr. Delbridge

Dr. Mackenzie

API Will Honor Three Technologists For Their Service to Refining Industry

THREE leaders in the cooperative technical work the American Petroleum Institute has carried on in the refining branch of the industry are to be especially honored at the meeting of the API Refining Division in Houston, April 4-7. The honors are in the form of the first awards in the Refining Division of the Certificates of Appreciation authorized by the API directors for outstanding service to the Institute.

The three individuals and the services for which they are to be cited are:

Walter Samans, chief mechanical engineer and administrative engineer, Sun Oil Co., Philadelphia, for his continuous work over the past 20 years as chairman of the API Unfired Pressure Vessel Committee in the standardization of the construction code for this type of vessel used in oil refining processes. This work has been rendered more difficult by the fact it had to recognize standards as set up in other industries, and also the legal safety limits in various states. Mr. Samans also has been active on other technical committees of the API Refining Division.

Dr. K. G. Mackenzie, assistant to the vice president and chief technologist, Refining Dept., The Texas Co., New York, for his work as chairman of the Refining Division Automotive Research Committee in directing the cooperative work by the oil companies on motor fuels and lubricants. He also is being honored for his fostering the API standardization program on petroleum products and lubricants, which has been carried on through Committee D-2 of the American Society for Testing Materials.

Dr. T. G. Delbridge, formerly director of research and development, Atlantic Refining Co., Philadelphia, and now retired, for being an outstanding leader in the development of the policies of the API Refining Division. Dr. Delbridge also served as chairman of the API Central Committee on Refining and a number of other important committees.

The major portion of Mr. Saman's professional career has been in the petroleum industry. His interests, as evidenced by his work in various technical society activities, has been primarily on tanks and pressure vessels. Born in Goes, Holland, he received his formal education in Philadelphia, obtaining a B. S. in M. E. degree from the University of Pennsylvania in 1905.

Except for a 10-year period with the Bessemer & Lake Erie Railroad, Mr. Samans was associated with Atlantic Refining Co. in various engineering capacities from 1905 to 1937. Since 1937 he was been with Sun. His active committee work with API began in 1926.

Besides serving actively in committee work with the ASME, the American Welding Society, and other groups, Mr. Samans participated in groups concerned with oil storage and handling problems of the military during the recent war. He was made chairman of the Engineers' Advisory Committee on Oil Storage to the Council of National Defense in 1940.

From August 1941 to December, 1943, he was with the Navy as Petroleum Consultant on Fuel Terminals and has been under contract in a similar capacity through Sun Oil Co. on special service as required.

Dr. Mackenzie, native of New York City where he was born in 1887, received his scientific training in chemistry at Yale University. He joined The Texas Co. as consulting chemist in 1911.

His work with the API began almost with its organization. He took a leading part in the organization of the Cooperative Research Council and was one of the six members representing the API and one of the incorporators of the CRC. As secretary of the Council, he took a very active part in the Technical Advisory Committee of the Petroleum Industry War Council, including active field work in connection with the Synthetic Rubber Program.

From 1913 to 1920, Dr. Mackenzie was secretary of Committee D-2 of the ASTM, and from 1920 to 1930 was vice chairman of this committee. He also was a member of the executive committee of ASTM from 1926 to 1928, vice president in 1929-30, and president in 1930-31.

Dr. Delbridge's career with Atlantic Refining Co. began in 1909 as works chemist and ended with his retirement in October, 1947, after 12 years as manager of the research and development department. Born in Batavia, N. Y., in 1884, received an A.B. degree from Union College, Schenectady, in 1903, and a Ph. D. from Cornell University in 1907.

During his activities with the API, Dr. Delbridge has been a member of the Lubrication Committee, Automotive Research Committee, the Committee on Petroleum Products, subcommittee on viscosity standards, and Committee on Measuring, Sampling, and Testing Crude Oil, as well as chairman of the Program Committee of the Refining Division.

He was chairman of the Technical Advisory Committee of the Petroleum Industry War Council during World War II, and has served as vice chairman of ASTM Committee D-2 on Petroleum Products and Lubricants, and as a director of the CRC.

55,000-Bbl. Tanks Are Floated To New Sites by Canal and Locks

FIVE 55,000-BBL. TANKS at the Sun Oil Co. refinery at Toledo were recently moved to new locations by floating them on a specially built canal, with locks to overcome the change in grades encountered. The maximum distance a tank was moved was 1510 ft.

The operation was done by the Catalytic Construction Co., to clear the site for Sun's $18,000,000 refinery expansion program at its Toledo plant. The method of moving the tanks by floating them in a prepared canal was chosen because it was less expensive and less damaging to the tanks than either dismantling or skidding them.

Each tank was 114 ft. in diameter, 30 ft. high, and weighed approximately 200 tons. The tanks were floated after careful preparations, and towed to their new sites by bulldozers, by towing cables attached to 3 lugs welded on the top of the bottom ring. Table 1 gives the data on the moving operation. The procedure is described by the Catalytic Construction Co. as follows:

The moving of the tanks was broken down into four operations; (1) preparing the tank, the new foundations and the dikes, (2) the transportation, (3) orienting and setting the tank, (4) disposal of the water in the canal.

The tank was prepared for floating by emptying its contents, safing it and cleaning it thoroughly. The bottom was inspected for holes, which were plugged or welded shut. The cleanout door was replaced and connections in the bottom ring were closed with blind flanges, pipe caps, or welded, depending on the type of connection. This procedure made the tank water-tight up to the level required for floating. The 3 lugs were then welded on the top of the bottom ring for attaching the towing cables.

The foundation at the new site was made up of a clay base with a 3-in. crown in the center. Around half of the foundation away from the entrance for the tanks, 5 posts, for steadying the tank while it was being placed in position, were set in the ground about 30 ft. apart, forming about 120 degrees of the circumference of the tank. The posts were of oak, 8x8 ins. and 8 ft. long. They were set 5 ft. in the ground, backfilled and solidly tamped.

The canal was laid out, as shown

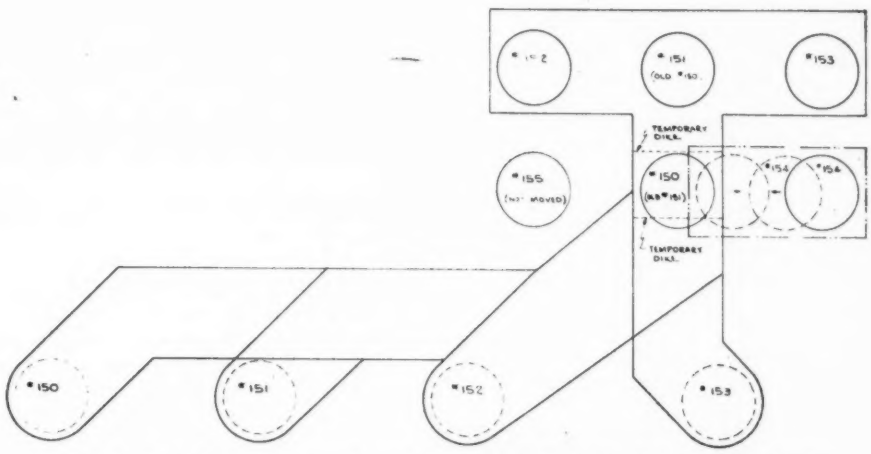


Fig. 1—Canal arrangement and location of docks for moving tanks

Fig. 2—Tank No. 152 en route to new location. Crane is removing dike lock so the tank can float to its new site at a lower level

TABLE 1—Data on Moving of Tanks

Tank Number	No. 150 (Old 151)	No. 151 (Old 150)	No. 152	No. 153	No. 154
Changes of grade, Ft.	603.80 to 606.50 to 602.50	606.50 to 606.50 to 602.50	607.70 to 606.50 to 602.50	606.75 to 606.50 to 602.50	604.05 to 604.05 to 602.50
Man-Hours	158	187	160	160	125
Moving Time (Hours)	8	8	8	8	8
Depth of Water (In. minimum)	18	18	18	18	18
Volume of Water (Millions Gals.)	2.27	4.25	4.27	4.27	2.24
Pumping Time (Hours)	40	72	72	72	40
Dirt in Dikes (Cu. Yds.)	2000	3100	2100	2100	800
Distance Moved (Ft.)	920	1510	980	970	230

in Fig. 1, so that it would serve for the movement of all the 5 tanks with a minimum amount of rebuilding of the dikes. Although the tanks would float in 18 ins. of water, the dikes were made several times this height in order to provide for clearance in high spots en route and for minor changes in level.

When a considerable change of grade was encountered, a lock arrangement was created by building a dike across the canal at the point at which there was the greatest change in grade. This method was adopted rather than raising the water level along the entire route because of the considerable amount of time required to pump the extra volume of water into the canal. When the tank was being moved to a lower grade, the dike was first built across the canal to a height sufficient to accommodate the water necessary to float the tank in the upper level. Earth for this dike was taken from the canal area so that, when the dike was broken, it was not necessary to move the earth out of the canal. Fig. 2 shows a tank being moved to a lower level.

The tank was then floated to the face of the dike and the dike broken to permit it to settle to the lower level. When the dike was leveled off the tank could be floated into position. When it was necessary to move a tank upgrade, it was floated in the lower canal for the maximum distance, then a dike was built behind the tank of sufficient height to hold the water necessary to float the tank into position at the higher grade. During the period in which the dikes were broken, the tanks were held firmly in place by cables.

Although it had been indicated that tanks of this size would float at 18 ins., it was necessary to pump to a depth of approximately 24 ins. in order to create enough buoyancy to free the tank from its old foundation. Before the tank was freed, two cables running from the previously attached lugs, were connected to bulldozers on either side of the canal and these were used to pull the tank along the canal. The second bulldozer was used to control the tank in moving rather than for power, since under calm conditions, the tank could be moved by several men. Sometimes it was necessary to place a third bulldozer in the pond, to push or pull the tank over a high spot, rather than to risk damage to the tank by too great a pull by the bulldozers on the opposite sides of the canal. Fig. 3 shows the towing operation.

Under windy conditions, only one bulldozer on the windward side was required, with another in the canal pushing or pulling the tank. During the actual moving of the tank, one or more men were inside the vessel plugging leaks with wooden plugs. Also, a crew was constantly watching for leaks in the dikes and repairing them as they occurred.

When the tank reached its new location, it was drawn into the semicircle of posts previously described and held in place by 3 cables. The procedure to orient the tank properly was as follows: On a drawing of the tank and its new location, three locating lines were run from fixed visible landmarks in the new tank area to the center of the tank and, where these lines intersected the shell, a target was placed on the shell before the tank was moved.

When the tank was about to be set, 3 transits were set up on the line between the landmarks and the center of the tank and the tank was oriented by shifting it around until the proper targets were sighted on the vertical cross-hairs of the corresponding transits. The tank was moved into final position by slackening one cable and tightening the others, or revolved by a fourth cable which partly circled the tank from one of the lugs attached for this purpose. When the tank was set, all lines were held taut before any water was released by breaking the dike.

The disposal of the large volume of water in the canal created a major problem because the uncontrolled flood could wash away the new tank foundation and undermine existing foundations. The water was discharged from the pond as slowly as could be allowed. A large ditch will control the water properly outside the pond because the major erosion occurs in the center of the ditch in a vertical direction.

The longest moving of a tank, 1510 ft., was accomplished in 8 hours actual moving time. This was preceded by 72 hours of pumping water, with pump capacity of 60,000 gals. per hour. The canal contained about 4,250,000 gals. of water, and the move was accomplished with 187 man-hours. The tank was in as good condition on its new foundation as on the old one, plus the advantage that the leaks in the bottom had been plugged and subsequently permanently fixed.

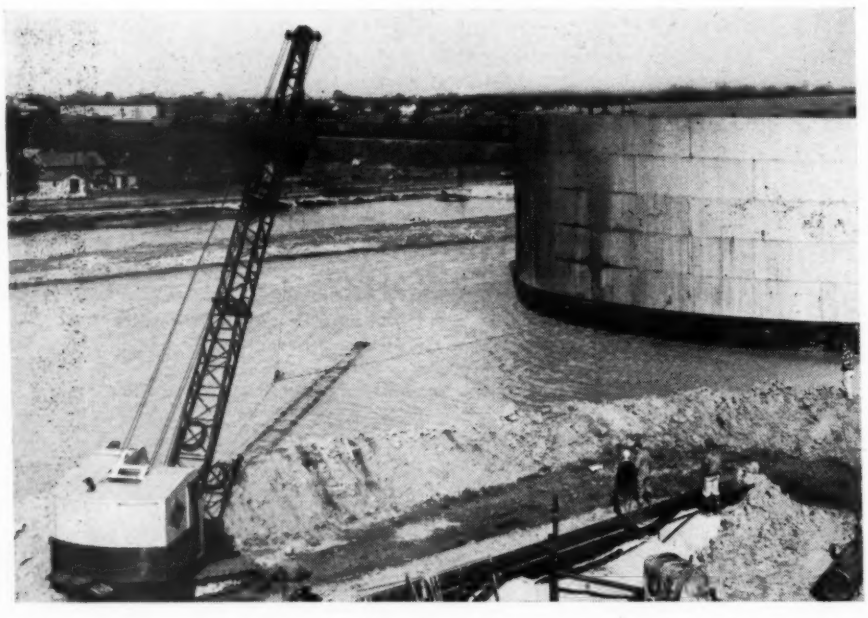


Fig. 3—Tank 152 being towed by bulldozer by towing lines attached to three lugs welded on the top of the bottom ring

Aerial photograph of Los Angeles showing a smog layer over a portion of the city. (Fairchild Aerial Surveys, Inc.)

The Petroleum Industry and SMOG

By HOMER REED, MYRL A. REAUGH, and ARTHUR F. STRIBLEY, Jr.,
Union Oil Co. of California

Petroleum refiners in the Los Angeles area, even though their plants are not believed contributing to the eye-irritating smog there, have taken a principal part in the smog relief program, through their Smoke and Fumes Committee of the Western Oil and Gas Assn. Research departments of the individual oil companies initiated studies to determine the nature and extent of contaminants in the air. The research program was later expanded and transferred to Stanford Research Institute.

In addition the refiners took direct steps to minimize air contamination from sulfur dioxide resulting from refinery operations. The burning of sludge sulfuric acid was voluntarily discontinued. A program costing several millions to remove sulfur from cracker fuel gas before it is burned is expected to be in operation in 1949.

The Authors

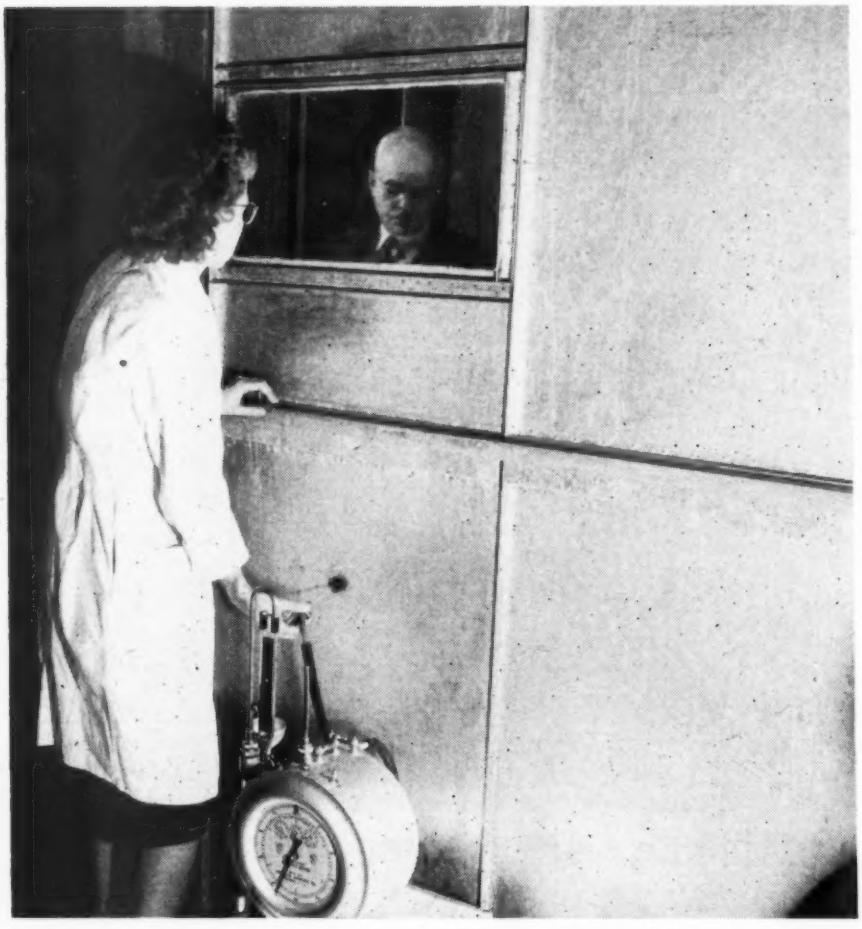
Homer Reed is chief engineer, Myrl A. Reaugh is supervisor of manufacturing economics, and Arthur F. Stribley, Jr. is chemical engineer, all members of the Manufacturing Dept., Union Oil Co. of California, Los Angeles.

SMOG (a contraction of the words, smoke and fog) has become a matter of increasing concern to the residents of the Los Angeles area during recent years. Smog denotes a condition in which natural haze and air contaminants from many sources mingle to produce a murky atmosphere which sometimes, but not necessarily, causes eye irritation.

This phenomenon is not new to the Los Angeles area, as reports of its presence date as far back as 1912. However, a marked increase in the frequency and severity of smog has been noted in the past decade during which the area has experienced a phenomenal increase in population as well as industrial growth.

Smog of the severe eye-irritating type occurs in the Los Angeles area as many as 20 times a year. This type is generally experienced in the late summer or early fall. Less intense smog, noticeable mainly by the murky atmosphere, occurs much more frequently and may appear at any time of the year. Although air pollution is a problem in other cities, particularly in the coal-burning areas of the east, frequent and eye-irritating smog seems peculiar to the Los Angeles area.

In 1946, a Smoke and Fumes Committee was formed within the petroleum industry operating in the area for the purpose of ascertaining the nature and sources of smog. This



Artificial smog chamber at Stanford Research Institute, used for measuring the eye-irritating effects of suspected impurities in the atmosphere. Dr. R. E. Scantlebury, physiologist, is undergoing test while an operator outside adjusts the controls

committee was made up of executives of seven major petroleum refiners and a representative of the independent refiners in this territory.

It soon became apparent that efforts to reduce smog were hampered severely by the lack of scientific data concerning air pollution. As a contribution to the public welfare, the Smoke and Fumes Committee (now a committee of the Western Oil and Gas Assn.) instituted an extensive program of research on this problem. This program was initially undertaken within the research departments of the various contributing petroleum companies. Later the entire effort was coordinated and expanded under the direction of the Stanford Research Institute.

The magnitude of the problem in determining what is smog and where it derives can be appreciated best when the possible sources of air contamination in the Los Angeles area are considered. Among others, the following all contribute large quantities of combustion and other products to the atmosphere:

Trash burning in both home incinerators and public dumps
Electric power plants, railroads and space heating units
Engine exhausts from automobiles and trucks
Iron and steel foundries
Brass foundries
Fish and fish oil processing
Food and meat processing
Petroleum production and refining
Paint and varnish manufacturing
Rubber production and processing
Lumber processing
Lime, cement and clay products
Roofing materials
Chemicals manufacturing

It is apparent with the large number of possible sources of air contamination that the smog problem is highly complex.

The first problem facing the Smoke and Fumes Committee and their research groups was: "What are the contaminants present in the air in Southern California?" Study of the literature indicated that analytical methods for the rapid and accurate determination of some of the suspected contaminants were lacking. Therefore, much of the initial research effort was directed toward the improvement or the development of entirely new analytical procedures, some of which involve the determination of contaminants in concentrations as low as 0.001 part per million.

Due in large measure to this initial research effort, analyses for such air contaminants as sulfur dioxide, sulfur trioxide, carbon monoxide, nitrogen oxides, elemental sulfur and aldehydes have become routine. Currently these analyses are being conducted under the sponsorship of the petroleum industry on a daily basis (and in the case of sulfur dioxide on a continuous basis) at a number of locations in Southern California. Dust and aerosol samples, collected from various points in the area, have been subjected to spectroscopic and chemical analysis and examined under the electron microscope.

The results of thousands of analytical tests made on a day-to-day basis indicate the following contaminants are present in the air in the downtown Los Angeles area:

Contaminant	Usual Range In Concentration (in ppm)
Sulfur dioxide	Trace — 0.5
Sulfur trioxide	Nil — 0.1
Aldehydes	Nil — 0.3
Carbon monoxide	Nil — 0.2
Nitrogen oxides	Nil — 0.5
Sulfur (elemental)	Nil — Trace

A wide variety of metallic contaminants has been found in dust samples, however, the main contaminants appear to be those commonly found in dirt. Even so, the Los Angeles atmosphere was found to have a relatively low particulate count.

To determine how the known contaminants result in or contribute to smog, the Stanford Research Institute is studying three phases of the smog problem as follows:

(1) What are the factors in smog that contribute to eye irritation?
(2) What are the factors in smog that result in reduced visibility?
(3) What are the meteorological factors contributing to smog? Although the studies are not complete, some valuable facts have already been established, and methods as well as equipment for future studies have been developed.

To obtain a measure of the irritating action of known air contaminants, the Stanford Research Institute has built a "smog chamber" which consists of a small, airtight room into which measured quantities of contaminants can be introduced. By observing the increased blinking of a

subject within the chamber, as well as by other measurements, the irritability of a given material can be determined. As yet the principal irritating factors in smog have escaped detection, however, a great deal has been learned about possible irritants.

The progress in this line of research is evidenced in the case of irritability studies on formaldehyde. Formaldehyde in the vapor state did not produce eye irritation in "smog chamber" studies in concentrations of less than 5 ppm. Since analytical studies on smog indicate that this contaminant is not present in concentrations above 0.5 ppm, it might be concluded that this contaminant could be ruled out as an irritant suspect. However, in subsequent tests in which formaldehyde was introduced with salt water in the form of an aerosol, definite irritation was noted at concentration as low as 0.7 ppm. It is possible that the physical form rather than chemical structure of a contaminant is of salient importance in determining its irritability.

In connection with the visibility reduction aspects of smog, the Stanford Research Institute studies have resulted in several important developments. One of these is a photographic method of measuring the degree of visibility much superior to the previously used method which depended upon visual observation of distant objects. This new visibility measure will be particularly valuable in making direct comparisons with future determinations.

Studies in a transmissometer, a photoelectric device which measures the degree of opacity of a column of contaminated air, indicate that sulfur trioxide forms a mist in the same concentration as those found under smog conditions. However, totaling the effect of natural haze, as determinded in other non-industrial Pacific Coast areas, with that resulting from the sulfur trioxide concentration in the air does not account for all the haziness observed. Thus other undetermined visibility limiting factors appear to contribute to smog.

As a result of the study of meteorological factors, a Smog Index or method of predicting smog has been developed by the Stanford Research Institute. Smog Index is calculated from an empirically developed formula made up of five variables as follows:

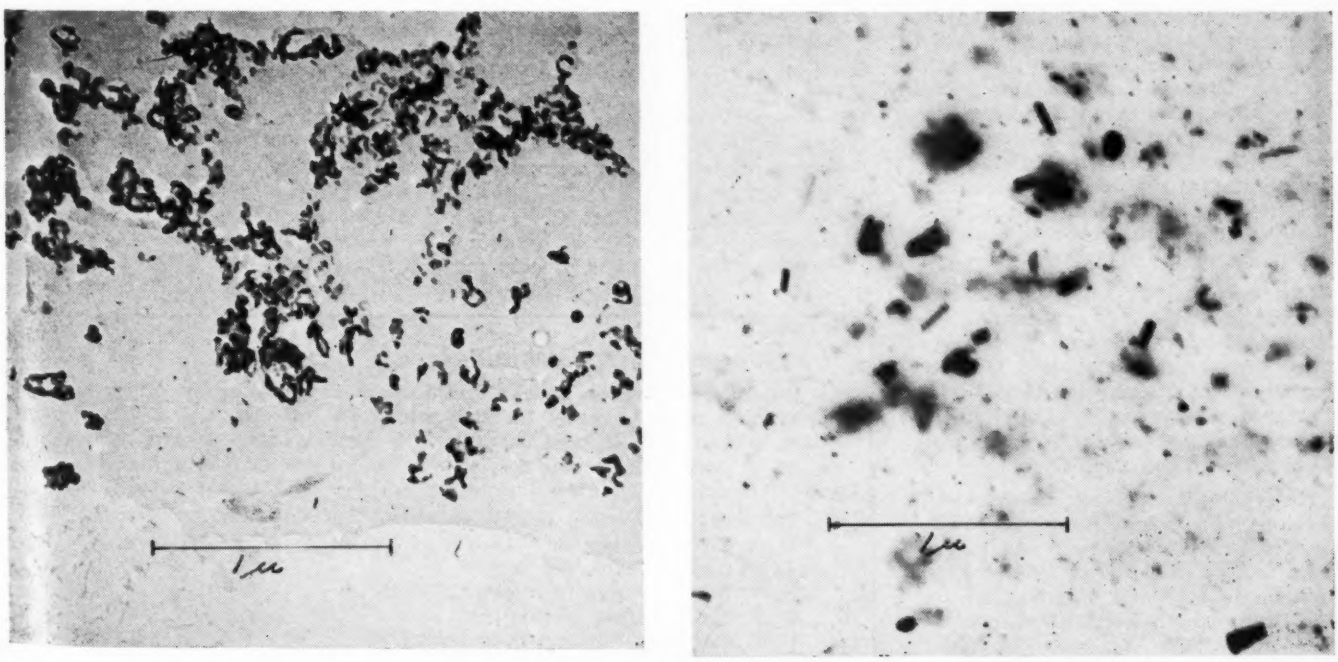
1. Wind movements for 24 hours.
2. Noon visibility in miles.
3. Relative humidity at noon.
4. The difference between the day's 24-hour mean temperature and the normal mean temperature.
5. The height of the temperature inversion level.

This index was calculated for the two-year period July, 1945 to July, 1947, and found to give good correlation with actual smog complaints over the same period. The factors of upper air pressure, amount of sunshine and surface air movements have also been shown to correlate with the formation of smog. As a result of these studies, it is possible to predict, often several days in advance, conditions of severe smog. These prediction methods will be invaluable in the future analytical studies of severe smog, giving warning so that equipment may be set up.

The future research program of the Stanford Research Institute is essentially one of completing the promising studies already underway in determining the nature of the irritating and visibility limiting factors of smog.

The contribution of the petroleum industry toward control of smog has not been limited to the support of the extensive research program outlined above. Major steps are currently being taken to minimize air contamination which may result from present refinery operating procedures, although sulfur dioxide and small quantities of sulfur trioxide are the only significant contaminants released by refiners, and there is no reason to believe that these compounds contribute to eye irritation. They are derived from refining California crude oils which contain relatively high quantities of sulfur.

In the early thirties, refining consisted mainly of a topping operation, with limited visbreaking of residuum and very little gas oil cracking. Essentially all of the sulfur released to the atmosphere under these conditions derived from burning sulfur-containing fuel oil in the furnaces. As the demand for gasoline increased, cracking operations were expanded. This expansion program was accelerated in the war years during which time the total cracking capacity (thermal and catalytic) of refineries located in the Los Angeles area was increased by about 70%. As a consequence, greatly increased quanti-



Electronic micrographs of smog particles made from samples taken in Los Angeles. Samples of smog were electrically precipitated onto aluminum foil and transferred to collodion film.

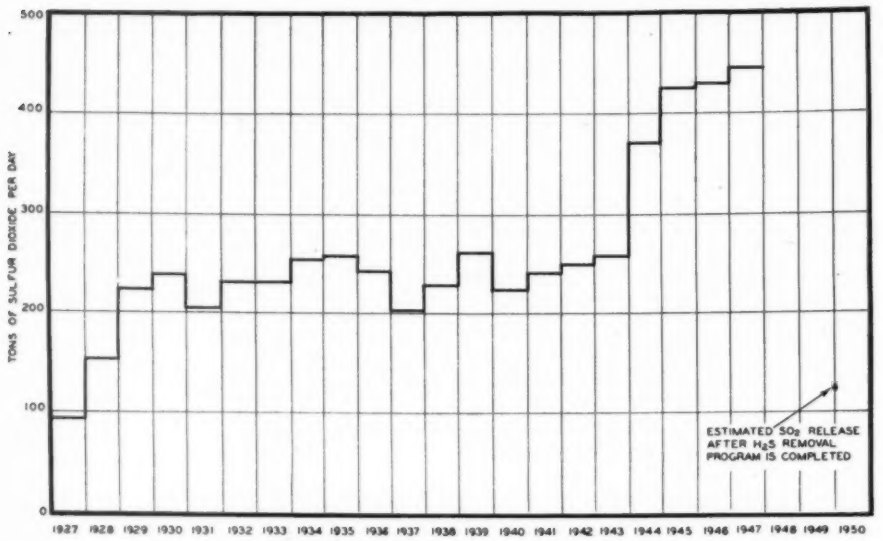


Fig. 1—Estimated sulfur dioxide released to atmosphere by refineries in Los Angeles County, 1927-1947

ties of sulfur dioxide are released in this area through burning of cracker fuel gas, whereas previously much of this sulfur was shipped out of the area in finished petroleum products.

The average amounts of sulfur dioxide released to the atmosphere in tons per day by refineries located in Southern California from the year 1927 to 1947 are shown in Fig. 1. These data show that the sulfur released was reasonably constant at from 200 to 270 tons of sulfur dioxide per day from 1929 through 1943, but thereafter the quantity released by major refining operations increased rapidly to 444 tons of sulfur dioxide per day in 1947. It should be noted that, although the amount of sulfur dioxide released to the atmosphere by the refineries is large, in no case is the concentration higher than 0.2% as sulfur dioxide in the stack gases. Further, the tonnage of sulfur dioxide released by the refineries in the Los Angeles area actually amounts to only about one-half of the total evolution, the balance being yielded mainly from burning sulfur-containing fuels by others.

The burning of sludge sulfuric acid which causes air contamination through the formation of large quantities of sulfur dioxide and trioxide has been voluntarily discontinued in Southern California by the refiners despite the higher cost of acid disposal using other means.

No economical process has yet been developed for extracting sulfur dioxide from stack gases in concentrations as low as 0.2% or below. This problem is currently under study by the Stanford Research Institute as well as by the various petroleum companies. The petroleum industry, seeking a more immediate solution, has approached the sulfur problem in another direction; namely, by the removal of sulfur from fuel gas before it is burned. This development, which will cost the various refiners several million dollars, is already partially completed and is expected to be in operation in 1949.

The sulfur removal program instituted by the petroleum industry is briefly outlined as follows:

1. Girbotol or other extraction plants have been or are being constructed by all major refiners in the Los Angeles area for the removal of hydrogen sulfide from cracker offgas.

2. The hydrogen sulfide extract instead of being burned will be converted to elemental sulfur by the Hancock Chemical Co.

Two major refiners, operating in the area have extracted hydrogen sulfide from cracker fuel gas for a number of years. In these cases the hydrogen sulfide extract is piped to adjacent plants where it is converted to sulfuric acid.

The Hancock Chemical Co. sulfur plant, being built at a cost of about $1,000,000, uses the Claus process for converting hydrogen sulfide to free sulfur. Transportation of the hydrogen sulfide is accomplished by piping hydrogen sulfide directly or by shipping or piping hydrogen sulfide-rich amine solutions from the extraction units located in the various refineries to the sulfur plant. This latter method eliminates the problems of transporting hydrogen sulfide under high pressure. The hydrogen sulfide-rich amine solution is steam-stripped to remove hydrogen sulfide and the regenerated solution is shipped or pumped back to the various refineries for re-use.

The chemistry involved in the production of sulfur from hydrogen sulfide is as follows:

$$H_2S + 3/2\ O_2\ (Air) \rightarrow SO_2 + H_2O$$
$$2H_2S + SO_2 \longrightarrow 3S + 2H_2O$$

Thus, by burning one-third of the hydrogen sulfide to sulfur dioxide, the remaining hydrogen sulfide reacts with the combustion products to produce sulfur. These reactions are carried out by partially burning the hydrogen sulfide under a steam boiler and then passing the products of partial combustion through a reactor containing bauxite which provides the surface required to allow reaction between the sulfur dioxide and hydrogen sulfide. The sulfur yielded is of high purity and is expected to be produced at a price competitive with that obtained from Texas and Louisiana.

It has been estimated, once the sulfur removal program is completed by the petroleum industry, that the amount of sulfur dioxide evolved by refineries in the Los Angeles area will be less than at any time since 1928.

Acknowledgment

Paul L. Magill, senior chemical engineer, Supervisor, Air Pollution Research, Stanford Research Institute, supplied the illustrations for the above article, which were first presented in the Interim Report on Smog Research made to the Committee on Smoke and Fumes of the Western Oil and Gas Assn.

The Smog Research Committee

The Committee on Smoke and Fumes of the Western Oil and Gas Association is the agency through which the oil companies with properties in the Los Angeles area are sponsoring the research program on smog, which is being carried on in the oil company laboratories and at Stanford Research Institute. Makeup of this committee is:

William L. Stewart, Jr., Union Oil Co. of California, Chairman
G. A. Davidson, Standard Oil Co. of California
D. E. Day, Richfield Oil Corp.
H. Y. Hyde, Tidewater Associated Oil Co.
F. S. Clulow, Shell Oil Co., Inc.
P. S. Magruder, General Petroleum Corp.
B. O'Connor, The Texas Co.
D. B. O'Neill, Independent Refiners Assn. of California, Inc.

80% Propane Recovery in Gasoline Plant Exceeds Its Design Figure

(Written from a Report by M. E. GARRISON, Project Engineer, General Petroleum Corp.)

Actual recovery of light ends has exceeded design requirements through a combination of good operating technique, selective absorption and control of wet gas and lean oil temperatures regardless of atmospheric temperature variations. Selective absorption is made possible by the control of oil-to-gas ratios for all absorptions, and by control of temperature of rich oil to the reabsorber. Recycle vapor buildup is prevented by recompressing raw gasoline vapors and returning them to the cooled raw gasoline liquid before depropanizing. A considerable recompression load is removed by partially de-ethanizing rich oil in the reabsorber.

RECOVERY OF PROPANE has been consistently above 80%, and of isobutane above 95%, during a 36-months run of the natural gasoline plant of the General Petroleum Corp. at Burrel, Calif. It was designed to recover 70% and 80% respectively of these materials in the composite wet gas the plant receives.

Three separate gas streams are processed, totaling 30,000 Mcf. per day, with initial field pressures of 50, 150 and 450 psi. Dry gas is delivered to two different gas pipeline systems, at 440 psi. and 500-600 psi.

Compositions of the three wet gas streams, and overhead dry gas streams from the absorbers and reabsorbers are shown in Table 1.

The wet gathering system serves three fields and is believed to be the largest ever installed for this purpose in California. That for the Helm field is 8 miles long and delivers wet gas at 440-450 psi. at the plant. A 50-psi. line parallels the high-pressure line to permit two-stage gas trap operation for the separation of oil and gas. It carries condensate for both lines through one plant and two field drips having level and pressure controls to raise condensate to successively higher elevations. Three heaters, of the circulating hot water automatic type, supply hot water to 80-ft. jackets surrounding the pipe, a gas temperature above 60° F. being maintained to prevent hydrate troubles.

The intermediate pressure line, 7.5 miles long, delivers 150 psi. wet gas from the Riverdale field to the plant. A 20 to 50-psi. wet gas line parallels the 150-psi. line for 2.5 miles, handling wet gas and tank vapors, eventually entering the 150-psi. line through a field booster station.

The low pressure line serves the Lanare field and is 4.5 miles long. It ties into the previously described 50-psi. wet gas line serving the Helm field. All lines have been laid to accommodate installation of field booster compressors when field pressures eventually decline.

In designing the plant proper, 450 psi. was selected as the optimum, in part because roughly only two-thirds of the wet gas would have to be compressed prior to absorption, and also because a considerable proportion of the dry gas would need compression to 450-lb. before sale to one of the pipe lines. The compression step delivering the balance of the gas at 500-600 psi. would be needed in any event.

Absorption System

Referring to Fig. 1, the Burrel plant is equipped with high and low pressure absorbers and a reabsorber. All the rich oil from the 450-psi. absorber flashes in the base of the 150 psi. absorber, and wet 150 psi. gas can be added here also to furnish required field fuel gas. Depropanizer vent gas and feed tank vapors enter this absorber to make maximum propane yield. The rich oil then is heated to 120-180° F. by exchange with lean oil from the still and flashed in the base of the 35 psi. reabsorber.

The reabsorber is designed for selective absorption, control of which is exerted by the gas-to-oil ratios on both absorbers, lean oil supply to the top of the reabsorber and temperature control of rich oil to the reabsorber. Raw gasoline vapors from the still accumulator, although omitted from Fig. 1 for simplification, are compressed from 30-35 psi. to 150-160 psi. and the raw gasoline make, excess above reflux, is pumped into these compressed vapors in the coolers on their way to the depropanizer feed tank. This flow eliminates the recycle vapor build-up commonly found in older California plants.

Elimination of the light ends—methane, ethane and some propane—from the rich oil by flashing in the reabsorber prevents contamination of the raw gasoline and actually is partial de-ethanization by selective absorption. Condensed in the raw gasoline, these light ends would lead to high recycle loads and require considerable recompression to prevent gasoline losses. This is achieved

TABLE 1—Analysis of Wet Gas Streams and Calculated* Dry Gas Compositions

Component	Helm 50-psi. Wet Gas Mol.-%	Riverdale 150 psi. Wet Gas Mol.-%	Helm 450 psi. Wet Gas Mol.-%	Composite 450-psi. Wet Gas ** Mol.-%	Composite 450-psi. Wet Gas ** Mcf.	450 psi. Dry Gas † Mol.-%	450 psi. Dry Gas † Mcf.	150 psi. Dry Gas †† Mol.-%	150 psi. Dry Gas †† Mcf.	35 psi. Reabsorber Dry Gas Mol.-%	35 psi. Reabsorber Dry Gas Mcf.
CO_2	0.32	0.63	....								
Methane	83.62	73.86	90.26	83.87	25,152.0	89.7	24,477.0	77.2	1,903.2	47.3	394.5
Ethane	5.76	10.12	4.32	7.11	2,135.6	6.7	1,838.6	12.5	309.1	24.1	201.0
Propane	5.20	7.75	2.91	5.29	1,587.5	3.5	952.5	10.1	249.6	27.5	229.0
i-Butane	1.33	1.87	0.73	1.21	365.5	0.1	21.9	0.1	3.5	0.7	6.0
n-Butane	1.97	3.52	1.02	1.94	583.0	Trace	9.0	0.1	1.5	0.4	3.5
C_5 Residue	1.80	2.25	0.76	0.58	176.4	...	....	...	....	...	....
Totals, Mcf.	8,000	13,000	9,787		30,000.0		27,299.0		2,466.9		834.0

* Slide rule accuracy.
** Includes 150 psi. composite stream compressed to 450 psi. and chilled to 60° F.; feed to 450 psi. absorber.
† Overhead from 450 psi. absorber.
†† Overhead from 150 psi. absorber.

80% Propane Recovery

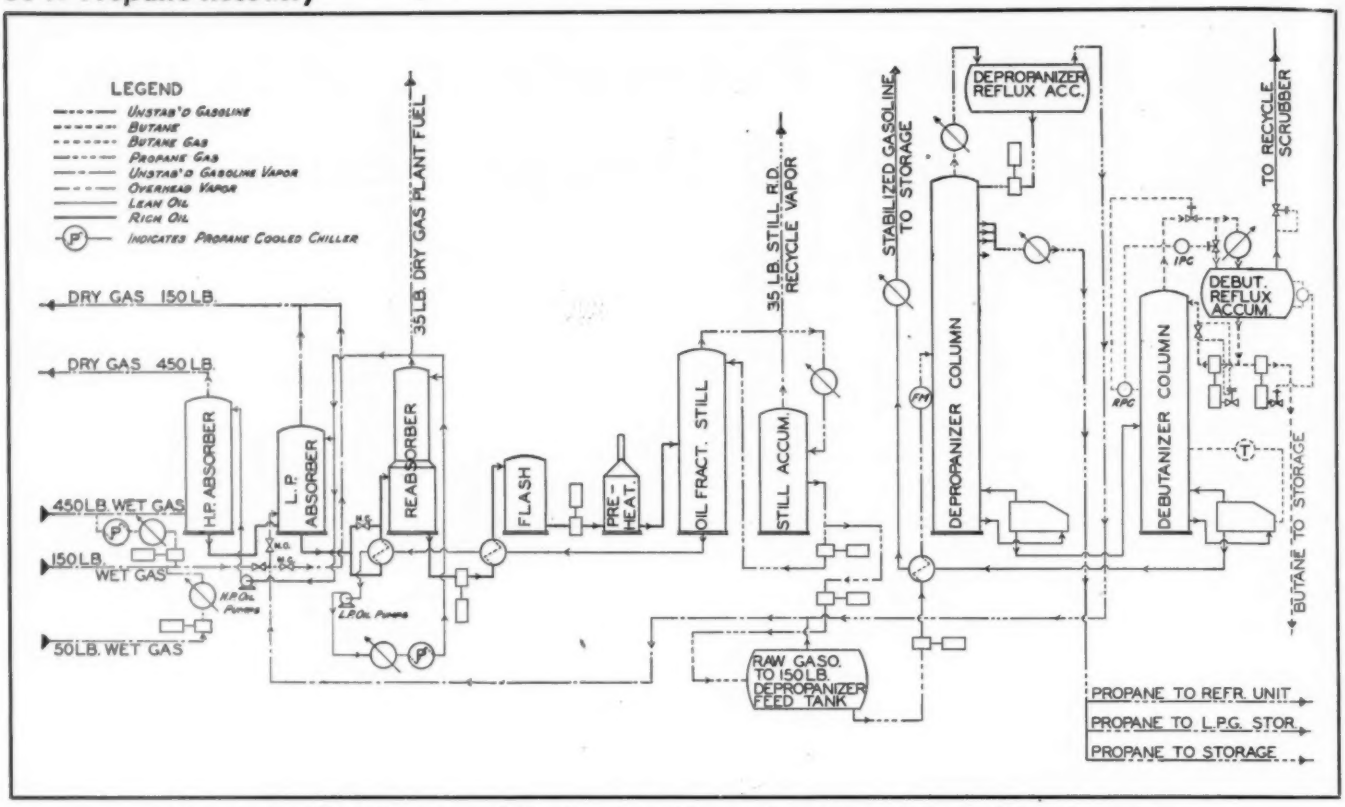


Fig. 1—Simplified flowsheet of the Burrel, Calif., gasoline plant of General Petroleum Corp.

at the expense of a small amount of additional oil circulation.

Tracing the oil flow through the plant, amounting to 448.5 gpm., lean oil from the atmospheric sections in the cooling tower is chilled to 45° to 60° F. with propane and is above 150 psi. It directly enters the 150-lb. absorber and 35-lb. reabsorber, while the balance of the stream is raised to above 450 psi. by the high pressure lean oil pumps supplying the high pressure absorber. Rich oil leaving the 150-psi. absorber is heated to 120°-180° F. by exchange with lean oil before entering the lower section of the reabsorber (or the preheat step may be by-passed, as desired) and rich oil leaving the reabsorber is heated to 300° F. by exchange with lean oil still bottoms before entering a flash tank.

Vapors from the flash tank, which has sufficient capacity to act as a surge tank for the whole fractionation system, enter the still at 300° F. Bottoms from the flash tank (fat oil) pass through a fired tubular heater and enter the still at 400° F. Still bottom temperature is 360° F., top temperature is 190° F. Lean oil is cooled by successively preheating cold rich oil to still and reabsorber, water-cooled, then chilled.

Gas Flow

The 50 psi. wet gas, after passing the usual scrubber, is compressed to 150 psi., after-cooled with water, and joins the 150 psi. wet gas stream entering the plant. This is piped alternatively to either the 450 psi. compressor header or directly to the 150 psi. absorber through a regulating valve controlled by the field fuel gas line pressure.

Vent gases from the depropanizer reflux accumulator and depropanizer feed tank also enter the wet gas line to the 150 psi. absorber. Vent gas from the depropanizer reflux accumulator alternatively may be connected to field fuel in case a maximum of propane recovery is not desired.

The 150-lb. wet gas compressed to 450 psi. is connected to atmospheric coolers and then to a wet gas chiller where it is further cooled to 60° F. by evaporating propane before enter-

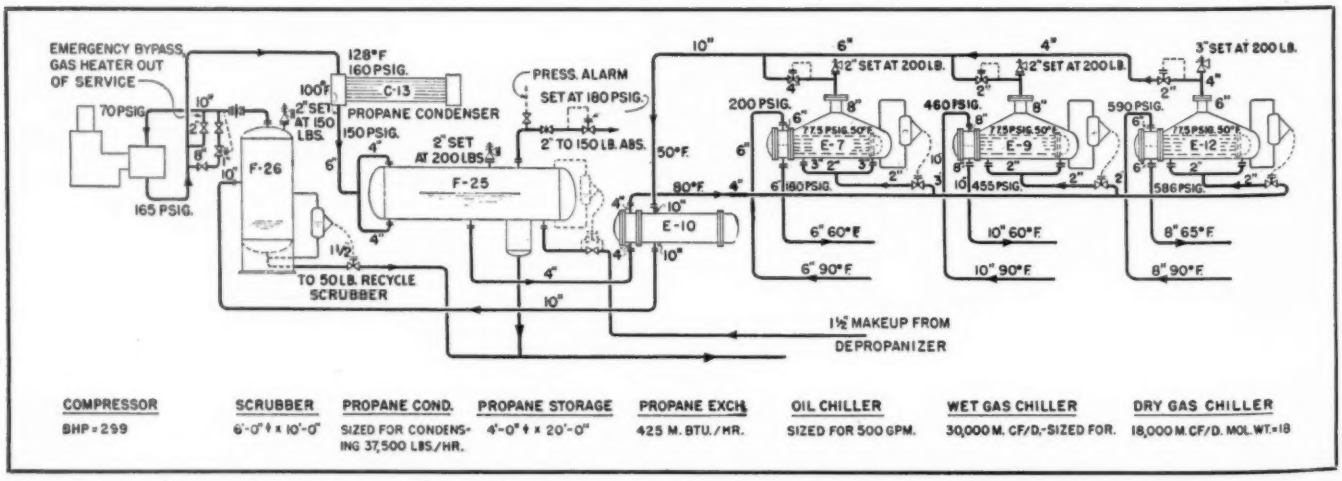


Fig. 2—Flow diagram for propane refrigeration unit at the Burrel gasoline plant. Position of the chillers in process sequence is shown in Fig. 1

ing the 450-lb. wet gas stream from the Helm field. This is scrubbed for condensate removal and charged to the 450 psi. absorber.

Dry gas overhead from the 450 psi. absorber enters a dry gas scrubber, meter and pressure regulating valves and splits. One stream is delivered to a gas pipe line at 450 psi. The other is compressed to 500-600 psi. for delivery to another pipe line, after-cooled and then chilled to 60° F. with propane. Contract with this latter pipeline requires delivery of from 14,500 to 18,000 Mcf. of gas at a controlled maximum temperature 5° above wet bulb and a minimum of 60° F.

Boiler and fired preheater fuel is taken from the dry gas leaving the 35 psi. reabsorber. Dry gas leaving the 150 psi. absorber passes through a regulating valve to field fuel supply. Compressors at the plant derive their fuel from this source also, although it is reduced to 30 psi. for this purpose. Entering the compressor fuel supply line scrubber also is an emergency line from the 50 psi. wet gas line for make-up purposes.

Drip condensates from the 450, 150 and 50 psi. wet gas lines are all collected in the 50 psi. wet gas scrubber. This, in turn, is connected to a dirty drip storage tank. Condensate from the 450 psi. compressor after-cooler is piped to the 150 psi. absorber and flashed. In turn it enters the 35 psi. recycle scrubber and flashes again. From here the clean condensate goes to a storage tank and eventually to the still. All dirty drips go to the oil reclaimer.

Fractionation Battery

Returning now to the fractionating still accumulator, Fig. 1, a part of this wild gasoline is returned as reflux and the balance is pumped to the depropanizer feed tank at 150 psi. Feed is preheated by exchange with stabilized gasoline bottoms from the debutanizer. The depropanizer has 10 more trays than normally required for this purpose, to permit withdrawal of 99% pure propane at from six to ten plates below the top. By using a large reflux accumulator and over-refluxing the column, maximum withdrawal of the propane content can be accomplished. Connections also have been installed to permit stripper operation at some future date for continuous removal of propane having 98-99% purity. The tray arrangement, jointly by C. F. Braun Co. and General Petroleum, utilizes a balanced vapor and liquid design permitting a higher than usual capacity in 48-in. diameter columns and a larger number of bubble caps per tray.

A part of the propane from the cooler serving the side-draw lines is used for refrigeration plant make up, another portion goes to LP-Gas storage, while the balance flows to propane storage. True overhead from the tower, also propane, is condensed with water and drops to the reflux accumulator for return to the tower.

Bottoms from the depropanizer pass at reboiler temperature to the debutanizer, which operates conventionally as shown in Fig. 1. Debutanizer make from the reboiler is heat exchanged with raw gasoline entering the depropanizer and finally cooled in atmospheric sections before going to storage. Condensed overhead make is piped to LPG storage.

The flow sheet for the refrigeration unit is shown in Fig. 2. Liquid propane from the depropanizer is used for filling the accumulator after it has been properly cooled. From the accumulator liquid propane passes through a heat exchanger in which cold propane vapor returning from the chillers in turn pre-cools the propane liquid before expansion. From this exchanger liquid propane enters the oil, wet gas and 600 psi. dry gas chillers in parallel, being controlled by liquid level controllers installed on each vessel.

In the chillers the propane is evaporated, passing through a back-pressure regulator to a common gas line. The back pressure is determined by the chiller temperature desired. Returning through the exchanger previously mentioned, the vapors enter the compressor intake scrubber and the compressor; discharge gas is totally condensed in atmospheric sections at 150 psi. and returns to the accumulator.

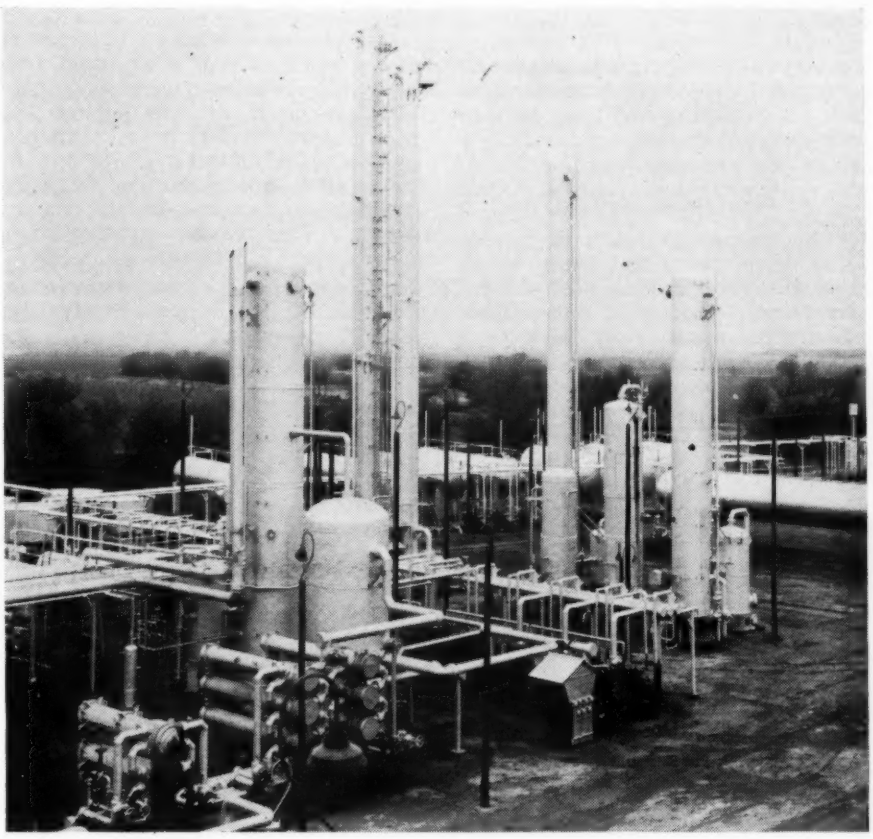
Any lubricating oil which might collect in the chillers is bled off to the intake scrubber and eventually to plant sewers.

The volume of propane to be handled by the compressor naturally will vary seasonally and with plant loads. A by-pass between compressor suction and discharge is available, to be opened when low gas rates in cold weather are encountered; a regulator operated by suction pressure later may replace the manual valve used now. This provision is necessary to prevent propane from condensing inside the compressor cylinder.

Oil Purifier System

The oil conditioning unit is used to clean up dirty absorption oil and recover absorption oil and gasoline from dirty drip condensate. It is a vertical fire tube heater having an evaporating capacity of 5 gpm. at 450° F.

Overhead vapor enters a transfer



Fractionating area of the Burrel plant showing, left to right, rich oil to lean oil exchangers, still and flash drum, depropanizer, debutanizer, reabsorber, 150 and 450 psi. absorbers, with scrubbers in front. Product storage is in background

Five Clark compressors, representing 2300 hp., compress wet and dry gas. Back end of the building houses parts storage and maintenance facilities

line laid to grade to a tubular condenser mounted on top of an accumulator. The accumulator liquid seals the vapor line and produces an effective vacuum on the heater of 10 in. Hg.

Connections are available from the accumulator returning reclaimed liquid to storage, the still or the reabsorber. Low gravity black oil accumulating in the heater is withdrawn at intervals to prevent coking.

This unit is not continuous and alternates between oil and dirty drip reclaiming services. If the volume of dirty drips or contaminated oil eventually exceeds conditioner capacity a reclaiming still may have to be installed. It will not produce a controlled molecular weight oil.

Compressor System

The compressor station houses seven compressors and three water circulating pumps, plus facilities for parts storage, overhaul and maintenance. There are two Clark type RA-4 two-cycle 400-hp. gas engine compressors, three Clark type RA-5 two-cycle 500-hp. gas engine compressors, two gas engine and one steam turbine driven engine water circulating pumps, and gas engine driven starting air and instrument air compressors. Duties of the five gas compressors are shown in Table 1, with gas streams designated by name and letter. Total compression horsepower is 2300.

Table 2 data show that balanced total compressor horsepower for each unit equals the rated engine horsepower for each service and for maximum gas loading of each compressor cylinder. Alternate services in case of breakdown or maintenance also are shown. It has been found possible to shut down the propane refrigeration unit in winter, due to excellent performance of the cooling tower. This provides another emergency spare set in case of need.

In laying out the station, provisions were made to permit shifting of a load from one unit to those remaining in operation in case of an engine or compressor breakdown. In the event there is an excess of 150 psi. wet gas to be compressed, it could be processed through the 150 psi. absorber and the dry gas flared if necessary. The compressor supplying 600 psi. gas to the pipe line is 100% spared.

Compressor cylinder jacket water is a closed system; two gas engine-driven pumps are used and a third turbine-driven unit is a standby. The pumps take suction on a surge tank, delivering to the engine jacket cylinders. Part of the water leaving the engine jackets cools the compressor cylinder jackets and returns to the surge tank, while the balance passes through atmospheric sections in the cooling tower before returning to the surge tank. A by-pass is installed around the coolers. This, together with the hot water from the compressor jackets, is used to control temperature of jacket water entering the engines to 120° F. Engine lubricating oil coolers are handled by a separate water circuit taken from the discharge of the cooling tower circulating pumps which returns to the tower basin.

Cooling Tower

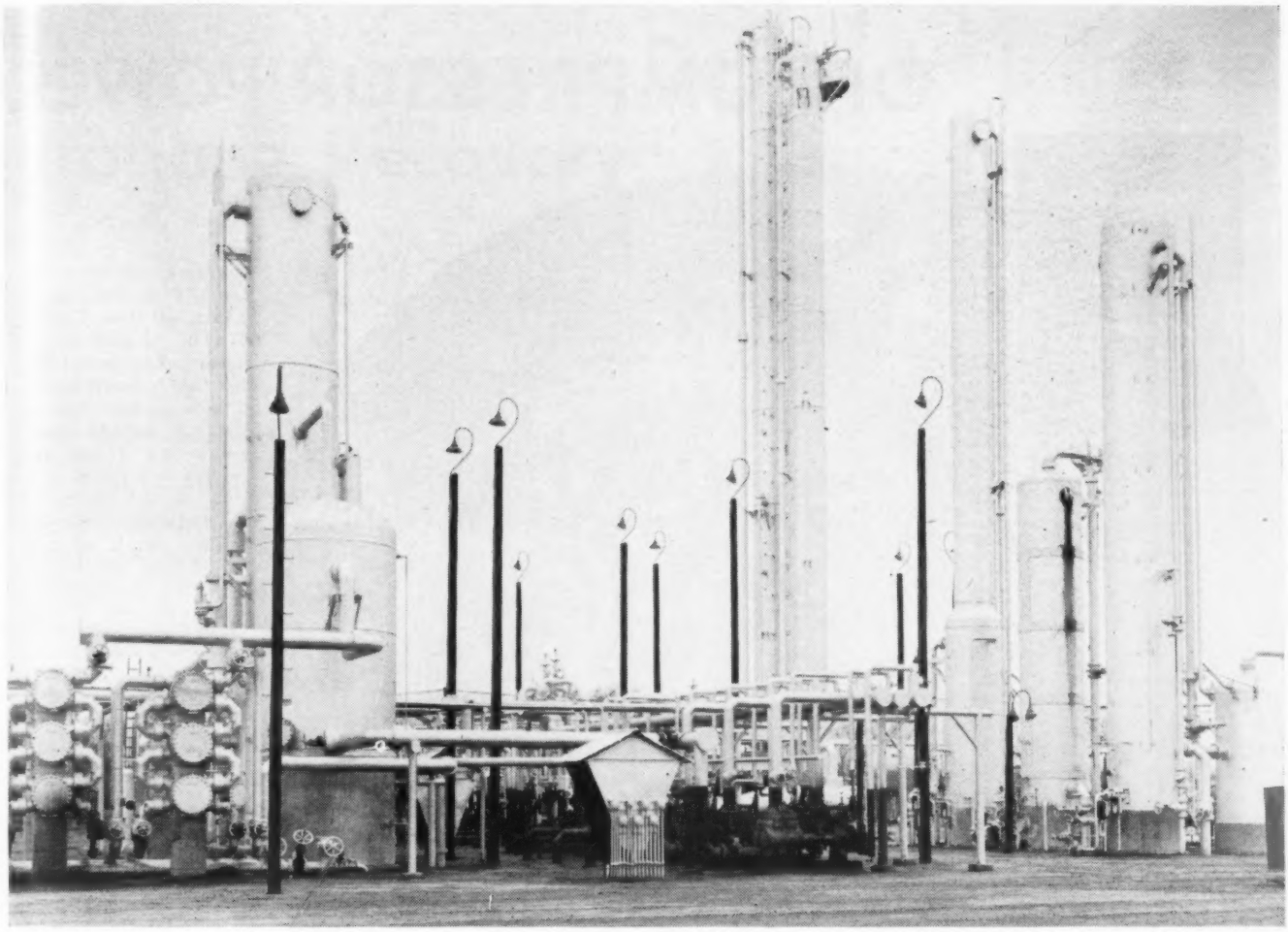
In planning the plant, preliminary weather investigation revealed periods for as high as 30 days with little wind available and wet bulb temperatures as high as 72° F. Also, ground fogs resulting from irrigation at certain times of the year cause high wet bulb temperatures.

A Water Cooling Equipment Co. induced tower was installed, having 24 six-foot bays and six cells. It is 24 ft. wide, 144 ft. long and 40 ft. high. A 12-ft. diameter fan with six stainless steel blades, driven by a Waukesha BZU gas engine through western reduction gearing, completes each cell. Atmospheric cooling sections 20 ft. long are stacked 4 ft. high in the base of the tower.

The cooling tower is rated to handle 7200 gpm. from 100° F. to 80°

TABLE 1—Gas Compressor Detail and Service

		General Service						Alternate Service				
Engine HP	Compressor Gas Service	Gas Symbol	Cylinder Size, Ins.	MMcf	Suct. Psi.	Disch. Psi.	Comp. BHP	Gas Symbol	MMcf	Suct. psi.	Disch. psi.	Compr. BHP
400	Recycle Gas	D	12x14	1.35	35	160	100	..	...	...	...	...
	Propane		12x14	...	...	...	...	E	1.47	55	165	50
	Propane Gas	E	(2)12x14	6.50	70	165	300	A	5.32	45	155	342
	Propane Gas		(2)12x14	...	...	...	...	E	5.62	55	165	317
400	50 psi. Wet Gas	A	12x14	2.52	45	155	162	...	...	...	...	...
	Recycle Gas		12x14	...	...	...	...	D	1.35	35	160	100
	150 psi. Wet Gas	B	(2)7x14	3.56	150	460	230	B	4.74	150	460	306
500	50 psi. Wet Gas	A	12x14	2.66	45	155	171	None				
	150 psi. Wet Gas	B	(2)7¾x14	5.10	150	460	328	None				
500	50 psi. Wet Gas	A	9¼x14	1.50	45	155	97					
	150 psi. Wet Gas		9¼x14	(single acting) (Double acting multiply by 2→				B	1.74	150	460	112
	150 psi. Wet Gas	B	7¾x14	3.00	150	460	194	...	...	...	...	...
	430 psi. Dry Gas		7¾x14	(Variable volume 4.5 MMcf to 9.00 MMcf unloader→				C	9.0	430	600	199
	150 psi. Wet Gas	B	7¾x14	3.00	150	460	194	...	...	...	...	...
	430 psi. Dry Gas		7¾x14	(Hand operated fixed clearance)				C	9.0	430	600	199
500	50 psi. Wet Gas	A	9¼x14	1.50	45	155	97	...	...	...	...	...
	150 psi. Wet Gas		9¼x14	(single acting) (Double acting multiply by 2→				B	1.74	150	460	112
	430 psi. Dry Gas	C	(2)7¾x14	18.00	430	600	398	←Var. Vol. 14.5 MMcf to 18.0 MMcf				
	150 psi. Wet Gas		(2)7¾x14	(Variable volume 4.5 to 6.00 MMcf—→				B	6.00	150	460	385



General view of process area of the Burrel plant, showing in foreground rich oil to hot oil exchangers, left, and process pumps, center. Flash drum and still are visible at left. Vessels at right are: depropanizer, debutanizer, reabsorber, 150 psi. and 450 psi. absorbers and high pressure gas scrubber

F. with a 72° F. wet bulb. This requires 0.4 in. of water draft at the entrance to the fan duct, representing a fan velocity of approximately 302 ft. per min. Other design features of the tower include:

1. Draft eliminators to prevent water carryover.
2. Removable cooling water decks having sufficient strength to permit removal for cleaning and hosing.
3. Vapor stack with damper, installed vertically from the atmospheric sections through the drift eliminators to permit removal of hot water vapor.
4. Double outside ventilated wall construction.
5. Pick-up and redistribution system with water control levers carried down to permit ground level operation.
6. Special hot water control arrangements on certain cooling sections; i.e., avoiding hydrate formation in cooling wet gas.
7. Coils alternately spaced with passageway between to permit easy maintenance access.
8. Stacking of atmospheric cooling coils with cold services above hot to economically permit flow of sufficient water to reduce scaling tendencies.

Horizontal duplex steam pumps are used for feed and reflux duties. A throttle valve placed in the discharge line from the pump provides the necessary pressure drop, varying with the rate, which controls steam to the pumps. This practice has been found to avoid the pulsation troubles so common with conventional rate control methods.

Exhaust steam from the duplex pumps as well as from those in the storage and shipping areas was balanced against heat requirements of the reboilers serving depropanizer and debutanizer, the feedwater heater and for still agitation purposes. For control it was found desirable to provide slightly less exhaust steam than would be required, making up the difference with a small amount of live steam. For this reason the remainder of the pumping loads such as high and low pressure lean oil pumps, are gas engine driven.

All steam-driven pumps exhaust to a common header operated at 40 to 60 psig. which supplies the feedwater heater and fractionator reboilers. Steam to the still is rate controlled, and that to reboilers by tower temperature-controlled regulators. The feedwater heater operates behind a pressure regulator at 2 to 5 psig. and steam from pumps in the shipping areas also can be tied to this low pressure line. Boiler feedwater pumps exhaust directly into the feedwater heater line. A reducing regulator controls live steam make-up to the exhaust steam header.

Steam condensate returns from reboilers and traps to a flash or surge tank at the classifying sump. Any oil is skimmed off into the sump and the water returns as feedwater. Cold condensate water from gasoline dewatering pots and the still run-down accumulator is taken to the sump also for removal of gasoline and then is pumped to the feedwater tank.

The Burrel plant was constructed by Bechtel McCone Corp. under direction of General Petroleum Corp. engineers, of which M. E. Garrison was project engineer. Pacific Pipe Line Construction Co. installed the field gathering system and gas booster compressor stations.

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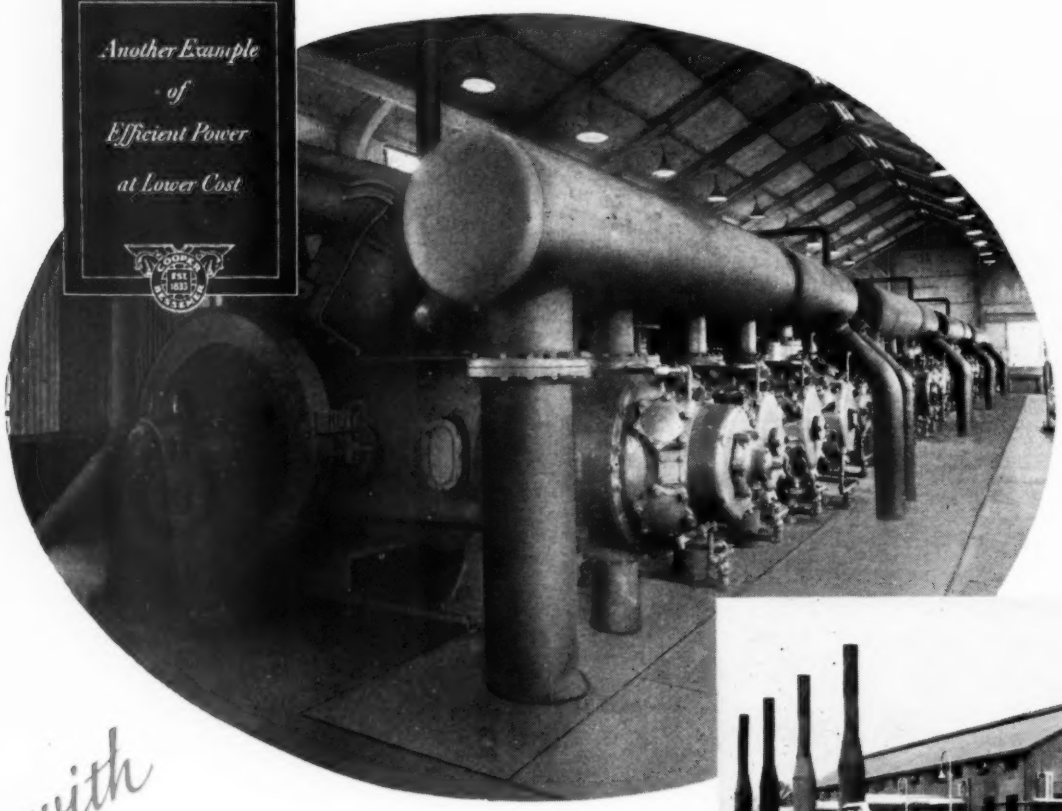

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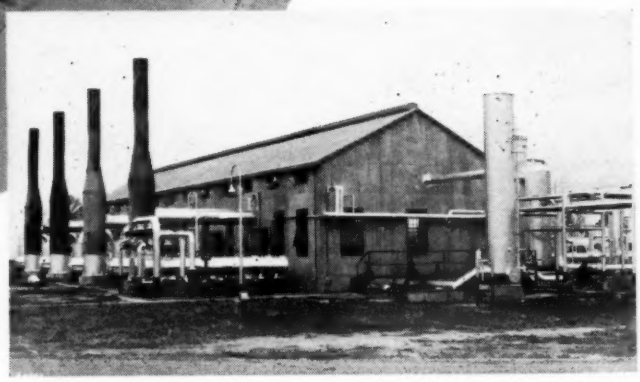

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Short Cut Process Design to Increase Propane Recovery in Gasoline Plants

By ALAN S. GLENDENING and CHARLES F. SANDERSON
Sanderson-Glendening, Consulting Engineers, Houston

Article 4

In the immediately preceding article of this series there was discussed at length the problem of refrigerating absorption oil systems in order to improve propane and butane recovery. Also considered in this article was an appropriate refrigeration system employing hydrocarbon refrigerant, and a fractionating de-ethanizer tower required to produce propane of commercial purity.

This month the authors present a set of calculations based on the principles discussed in Article 3 (March, 1949, pg. 258). The problem they present is that of determining the recovery rates of the various natural gas components and also the amount of refrigeration horsepower required in a high pressure absorption plant which is conventional except for the addition of refrigeration and a de-ethanizer tower. Flow diagrams of the process were included in Article 3, and it is suggested that reference be made to that article in order to facilitate understanding of the calculations presented herewith.

Sample Calculation

An existing plant is to be expanded in order to produce commercial propane and butane. Refrigeration will be applied to the absorber in order to make the most efficient use of the existing oil circulation. Total oil circulation is 125 gpm. (180 mol wt., 40° API), divided 75 gpm. to the main absorber and 50 gpm. to the reabsorber.

A new 24-tray absorber will be installed and the revised process will be as shown in Figs. 9 and 10 (Article 3). Absorption will take place at 500 psig. The propane product will contain 3% methane (mol basis). A total of 20,000,000 SCFD will be processed, having the following composition:

Component	Mol—%
Methane	69.0
Ethane	12.0
Propane	9.0
iso-Butane	1.5
n-Butane	4.5
iso-Pentane	1.0
n-Pentane	1.7
Hexane +	1.3
	100.0

This gas enters the absorption system at 500 psig. and 90°, and is partially liquefied under these conditions.

The problem is to determine the possible recovery of propane and heavier; the recompressor horsepower required; and the refrigeration load and compressor horsepower required.

Basis of calculation: 20,000,000 SCFD = 2200 mols/hr. MIT K's.

The specific gravity of the above gas is 0.876 which, according to a hydrate formation chart[3], will begin to hydrate at 500 psig. and 60°. After condensation in the chiller and absorber, this gas will be somewhat lighter and more resistant to hydrate formation, so 60° may be considered a minimum temperature for the absorption system without dehydration. Compute gas chiller load and condition of gas entering the absorber: chiller cools from 90 to 60°. The

TABLE 4—Gas Chiller Compositions

Composition	Tot. feed mols/hr.	K @ 90° & 500 psig.	Mols liq. l, @ 90°	K @ 60° & 500 psig.	Mols liq. l, @ 60°	Lbs. liq. @ 60°
Methane	1518.0	5.4	17.5	4.5	44.5	713
Ethane	264.0	1.19	13.3	0.98	32.2	969
Propane	198.0	0.52	21.4	0.39	51.1	2250
i-Butane	33.0	0.275	6.2	0.182	14.1	820
n-Butane	99.0	0.215	22.4	0.138	49.1	2855
i-Pentane	22.0	0.097	8.7	0.056	15.6	1126
n-Pentane	37.4	0.077	16.8	0.044	28.2	2034
Hexane +	28.6	0.012	24.0	0.005	27.6	2760
	2200.0		130.3		262.4	13527

At 90°, assume L/V=0.063, then L = (0.063) (2200)/1.063 = 130.4 (check)

At 60°, assume L/V=0.136, then L = (0.136) (2200)/1.136 = 263 (Check)

where mols condensed liquid, l = (L/V assumed) (total mols component)/($K+L/V$ assumed)

The calculation for lbs. of liquid at 90° is not shown here, but is 7526 lbs./hr.
Total lbs. to chiller is (2200) (0.876) (29) = 55,900 lbs./hr.

At 90°: liquid is 130.3 mols, 7526 lbs.
or mol wt. liquid is 7526/130.3=57.7 (152 Btu./lb.)
vapor is 2200 — 130 = 2070 mols, and 55,900 — 7500 = 48,400 lbs.
or mol wt. vapor is 48,400/2070 = 23.4 (314 Btu./lb.)
enthalpy of liquid is (7526) (152) = 1,140,000 Btu./hr.
enthalpy of vapor is (48,400) (314) = 15,200,000
Total enthalpy at 90° = 16,340,000 Btu./hr.

At 60°: liquid is 262.4 mols, 13,527 lbs.
or mol wt. liquid is 13,527/262.4 = 51.6 (136 Btu./lb.)
vapor is 2200 — 262 = 1938 mols, and 55,900 — 13,500 = 42,400 lbs.
or mol wt. vapor is 42,400/1938 = 21.9 (301 Btu./lb.)
enthalpy of liquid is (13,527) (136) = 1,840,000 Btu./hr.
enthalpy of vapor is (42,400) (301) = 12,770,000
Total enthalpy at 60° = 14,610,000 Btu./hr.

Gas chiller duty (90° to 60°) is 16,340,000 — 14,610,000 = 1,730,000 Btu./hr.

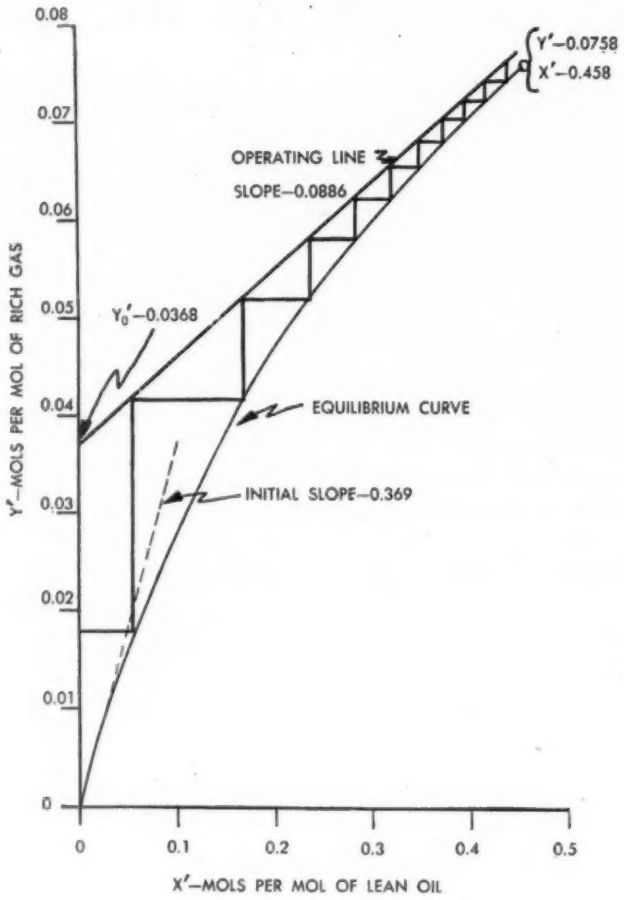

Fig. 17-a—Propane absorption diagram

changes in the amount and composition of the liquid phase for the conditions indicated are shown in Table 4.

Gas to the bottom tray of the absorber is obtained by difference between total wet gas and liquid condensed out at 60°, and is:

Component	Mols /hr.
Methane	1473.5
Ethane	231.8
Propane	146.9
iso-Butane	18.9
n-Butane	49.9
iso-Pentane	6.4
n-Pentane	9.2
Hexane +	1.0
	1937.6

The Sherwood method of calculation will be used.[2] It is a variation of the Kremser method[4], based on conditions at the bottom tray, and corrected graphically because of changing liquid-vapor ratio through the tower. Mols of rich oil off the bottom tray are not known in advance and must be assumed. A bottom tray temperature of 70° and a 40% tray efficiency will be assumed.

Theoretical plates = (0.4)(24) = 9.6.

Lean oil (180 mol wt., 40° API = 6.87 lbs./gal.) has (180)/(6.87) = 26.2 gals./mol, or at 75 gpm, = (75)(60)/(26.2) = 171.8 mols/hr.

From inspection of the vapor feed composition, we will assume 275 mols to be absorbed, or rich oil at the bottom tray is 275 + 171.8 = 446.8 mols/hr. Then liquid-vapor ratio at the bottom tray is (446.8)/(1937.6) = 0.231.

The absorption factor used in the Kremser and Sherwood methods is (liquid-vapor ratio/K), and per cent absorption is related to the absorption factor by the Kremser equation as obtainable from an absorption factor chart.[3] Quantities absorbed of each component are shown in Table 5.

Note that the computed total absorbed material (285) is greater than the assumed value (275). This is desirable since the following calculation will reduce the extraction rates somewhat.

The extraction rates of the key components—propane, iso-butane, and n-butane—must now be corrected graphically. Stoichiometric units will be used: Y' (mols of component in gas per mol of wet gas), and X' (mols of component in rich oil per mol of lean oil).

The slope of the operating lines of these diagrams will be (mols of lean oil)/(mols of rich gas) = (171.8)/(1937.6) = 0.0886.

The general equation of the equilibrium lines using the above stoichiometric units is:

$$Y' = KX' \ (\Sigma Y')/(1+\Sigma X')$$

The slope of the equilibrium lines at the origin is $K\Sigma Y_o'$ where $_o$ indicates the top of the absorber.

Mols residue gas is 1937.6 − 275 = 1662.6 mols/hr.

Propane Diagram

Initial slope of the equilibrium curve is $K\Sigma Y'_o$ = (0.43)(1662.6)/(1937.6) = 0.369.

At the rich end, Y' = (146.9)/(1937.6) = 0.0758; and in equilibrium at this point, $X' = Y'(1 + \Sigma X')/K(\Sigma Y')$ = (0.0758)(1 + 275/171.8)/(0.43)(1.0) = 0.458. This gives a point on the equilibrium curve: Y' = 0.0758, X' = 0.458.

Fig. 17a has been constructed accordingly, with 9.6 plates stepped off between equilibrium and operating lines, giving Y'_o = 0.0368, or mols propane in residue is (0.0368)(1937.6) =71.3. Mols propane absorbed (corrected) is 146.9−71.3=75.6 mols/hr.

Iso-Butane Diagram

Initial slope of the equilibrium curve is (0.213)(1662.6)/(1937.6)= 0.183.

At the rich end, Y' = (18.9)/(1937.6)=0.00975; and in equilibrium at this point, X'=(0.00975)(1+275/171.8)/(0.213)(1.0)=0.119.

From the diagram, Fig. 17b, Y'_o= 0.0017, or mols iso-butane in the residue is (0.0017)(1937.6)=3.3. Mols iso-butane absorbed is 18.9−3.3=15.6.

n-Butane Diagram

Initial slope of the equilibrium

TABLE 5—Quantities of Each Component Absorbed

Composition	K @ 70° & 500 psig.	Absorp. Fact. =0.231/K	Fraction Absorbed	Mols. Absorbed
Methane	4.8	0.0482	0.0482	71.0
Ethane	1.04	0.222	0.222	51.5
Propane	0.43	0.538	0.538	79.0
i-Butane	0.213	1.086	0.93	17.6
n-Butane	0.162	1.428	0.99	49.4
i-Pentane	....	....	1.0	6.4
n-Pentane	....	....	1.0	9.2
Hexane +	....	....	1.0	1.0
				285.1 mols/hr.

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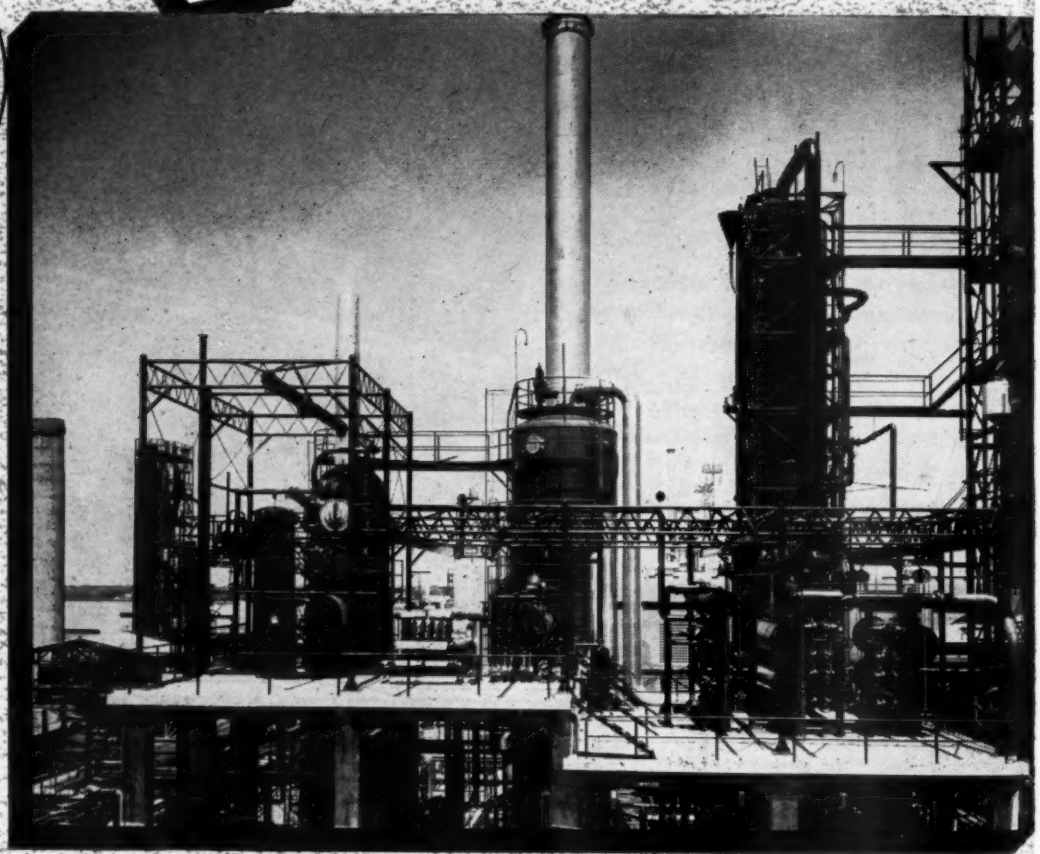

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curve is (0.162)(1662.6)/(1937.6) = 0.139.

At the rich end, $Y' = (49.9)/(1937.6) = 0.0258$; and in equilibrium at this point, $X' = (0.0258)\ (1+275/-171.8)/(0.162)\ (1.0) = 0.414$.

From the diagram, Fig. 17c, $Y'_o = 0.003$, or mols n-butane in residue is (0.003)(1937.6) = 5.8. Mols n-butane absorbed is 49.9 − 5.8 = 44.1.

The revised mols absorbed are as follows. Note that the new total (274.4) checks well with the assumed value (275).

Comp.	Mols absorbed	Tot. rich oil incl. liq. condensed in chiller
Methane	71.0	115.5
Ethane	51.5	83.7
Propane	75.6	126.7
i-Butane	15.6	29.7
n-Butane	44.1	93.2
i-Pentane	6.4	22.0
n-Pentane	9.2	37.4
Hexane + ...	1.0	28.6
	274.4	536.8
Lean Oil	171.8	171.8
	446.2 mols/hr.	708.6 mols/hr.

The rich oil now is flashed twice by dropping its pressure. The second flash will be at the pressure of the reabsorber and in fact may be performed inside the reabsorber, provided the latter is equipped with somewhat greater volume beneath the bottom tray. With the still operating at 60 psig. and 50 psi. drop through oil exchangers, still preheater, and lines; the reabsorber pressure will be 60+50=110 psig. Flash rich oil at 300 psig. and 110 psig.

Taking the molal average temperature of absorber rich oil and chilled condensate, the temperature of the total, 500 psig., rich oil will be approximately [(446.2)(70)+(262.4)(60)]/(708.6) = 66°. The temperature of the rich oil mixture will drop about 3° with each flash. Use 63° for the first flash, and 60° for the second. (These temperatures can be checked later by performing a heat balance around each flash. A slight error in the choice of flash temperatures will not affect the results appreciably, however).

Flash Calculations

The flashes are calculated by the same equilibrium procedure as was used in computing condensation in the gas chiller; see Table 6. Gases from these flashes are to be processed in the reabsorber at 110 psig. Assuming 90° lean oil to reabsorber, reabsorber bottom tray temperature should be about 105°. This temperature will be used for the calculation. Absorption factors will be based upon the liquid-vapor ratio at the bottom tray. Since the liquid-vapor ratio through the reabsorber will be approximately constant (this fact is rather characteristic of reabsorbers, but should be checked after the cal-

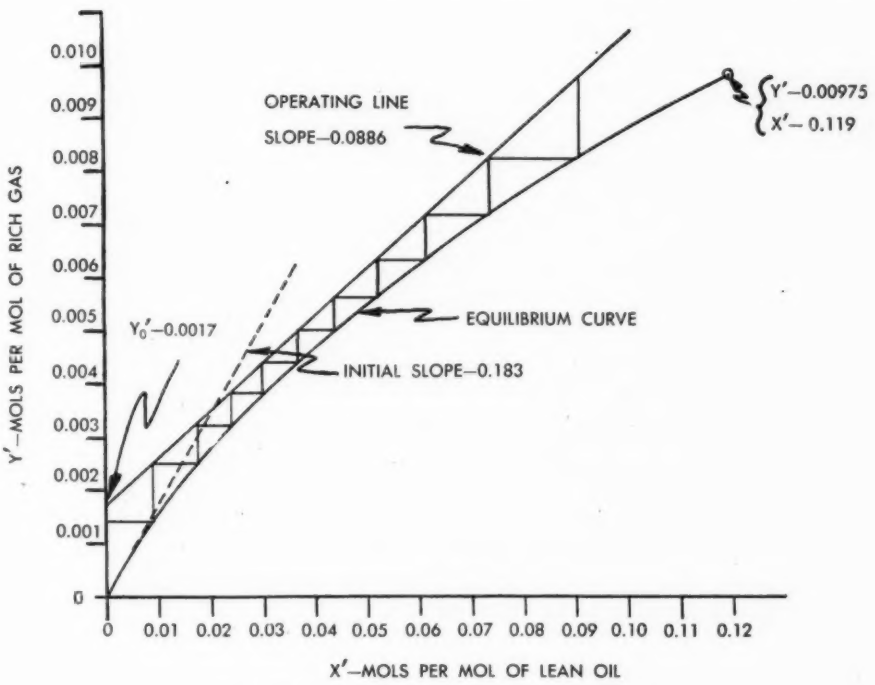

Fig. 17-b—iso-Butane absorption diagram

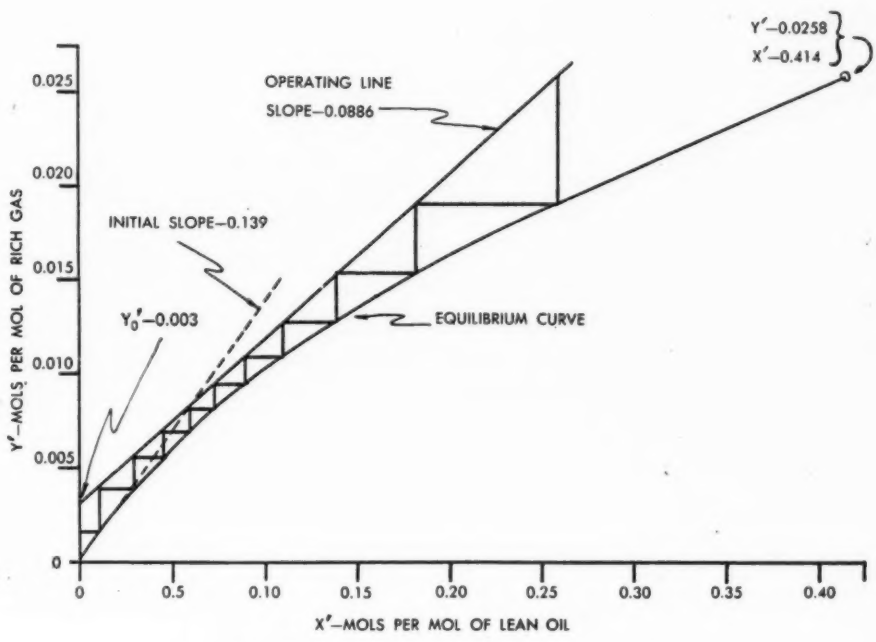

Fig. 17-c—n-Butane absorption diagram

TABLE 6—Rich Oil Flash Calculations

Composition	Tot. 500 psig. rich oil	K @ 63° & 300 psig.	Rich oil after 300 psig flash	K @ 60° & 110 psig.	Rich oil after 110 psig flash
Methane	115.5	7.35	60.1	18.0	14.7
Ethane	83.7	1.39	71.3	3.8	47.0
Propane	126.7	0.495	119.2	0.92	103.0
i-Butane	29.7	0.215	28.9	0.366	27.2
n-Butane	93.2	0.16	91.4	0.266	87.3
i-Pentane	22.0	0.063	21.8	0.098	21.4
n-Pentane	37.4	0.048	37.2	0.072	36.8
Hexane + ...	28.6	0.005	28.6	0.0066	28.6
	536.8		458.5		366.0
Lean Oil	171.8	0.000	171.8	0.000	171.8
	708.6 mols/hr.		630.3 mols/hr.		537.8 mols/hr.

culation), graphical corrections will be small and therefore will be ignored.

Assume the reabsorber has 18 trays which, at 40% efficiency, give 7.2 theoretical plates. Lean oil at 50 gpm = (50)(60)/(26.2) = 114.6 mols/hr. Gas entering the bottom tray is obtained by difference between the 500 psig. and 110 psig. rich oil in Table 6, and comes to 170.8 mols./hr. Assuming 34 mols are absorbed, the liquid-vapor ratio at the bottom tray will be (114.6+34)/(170.8)=0.87, and the absorption factors are given by 0.87/K. See Table 7.

As shown in Table 7, the calculated total mols reabsorbed (34.1) checks well with the assumed value (34). At this point, the assumed bottom temperature (105°) should be checked by means of a heat balance around the tower, based on 60° entering rich gas and 90° residue gas and lean oil. The actual check will be omitted here.

The sum of reabsorber rich oil and rich oil from the 110 psig. flash gives the total material to the still. This sum is:

Comp.	Mols/hr.
Methane	18.5
Ethane	54.3
Propane	116.6
i-Butane	29.6
n-Butane	93.1
i-Pentane	22.0
n-Pentane	37.4
Hexane +	28.6
	400.1
Lean Oil	286.4
	686.5 mols/hr.

Overall plant recoveries may now be calculated since production consists of the above less lean oil and less de-ethanizer tops. It will be assumed that no butane will be lost overhead of the de-ethanizer. De-ethanizer reflux will be refrigerated to 60° with 450 psig. operation. A 3% inclusion of ethane in the recovered propane will be allowed. The calculation is performed by the usual dew-point method:

Comp.	De-eth tops mols/hr.	K @ 60° & 450 psig.	Tops/K
Methane	18.5	5.0	3.7
Ethane	51.1	1.04	49.1
Propane	11.2	0.4	28.0
	80.8 mols/hr.		80.8

Net propane recovery is 116.6−11.2=105.4 mols/hr. Net recoveries and recovery rates for ethane and heavier are:

Comp.	Production Mols/hr.	Overall recov. rate, %
Ethane	3.2	1.2
Propane	105.4	53.3
i-Butane	29.6	89.7
n-Butane	93.1	94.1
i-Pentane	22.0	100.0
n-Pentane	37.4	100.0
Hexane +	28.6	100.0
	319.3 mols/hr.	

Recompressor horsepower is obtained by means of an equilibrium calculation at the surge tank. With the still at 60 psig., and with 85° cooling water, the surge tank will operate at about 55 psig. and 90°. See Table 8 for calculations.

TABLE 7—Calculations of Mols Reabsorbed

Composition	Gas to Reabs. mols/hr.	K @ 105° & 110 psig.	Absor. fact. 0.87/K	Fraction absorbed	Mols/hr. absorbed
Methane	100.8	23.4	0.0372	0.0372	3.8
Ethane	36.7	4.4	0.1978	0.1978	7.3
Propane	23.7	1.5	0.58	0.575	13.6
i-Butane	2.5	0.69	1.26	0.954	2.4
n-Butane	5.9	0.51	1.707	0.99	5.8
i-Pentane	0.6	...	...	1.0	0.6
n-Pentane	0.6	...	...	1.0	0.6
Hexane +	...	...	...	...	..
	170.8				34.1

TABLE 8—Calculation of Recompressor Throughput

Composition	To Surge Tank Mols/hr.	K @ 90° & 55 psig.	Liquid from surge tank	Recompressor Vapors from surge tank
Methane	18.5	38.	0.4	18.1
Ethane	54.3	6.7	5.5	48.8
Propane	116.6	2.15	30.2	86.4
i-Butane	29.6	0.92	13.3	16.3
n-Butane	93.1	0.67	49.2	43.9
i-Pentane	22.0	0.265	16.3	5.7
n-Pentane	37.4	0.208	29.3	8.1
Hexane +	28.6	0.023	27.7	0.9
	400.1 mols/hr.		171.9 mols/hr.	228.2 mols/hr.

From a compressor horsepower chart[3] at the above compression ratio and "n" value, brake horsepower per million SCFD is 57.2. Adjusting for 90° suction (550° R.) and doubling because of two stage operation; recompressor horsepower required is (57.2)(2)(2.07)(550)/(520) =250 BHP. A substantial safety factor should be allowed for flexibility of operation. It is recommended that 300 BHP be installed for recompressor service.

Refrigeration System

The de-ethanizer condenser duty will not be calculated here. Suffice to say that it is obtained by the usual fractionator calculation methods and with an ample safety factor applied, will be about 1,150,000 Btu/hr. for a 30-tray tower. The gas chiller duty has been computed previously as 1,730,000 Btu/hr., leaving only the oil chilling duty (absorber intercoolers) to be calculated. This is done by means of a heat balance around the main absorber as follows:

Assume lean oil in at 90° and residue gas out at 95°; rich oil out at 70° and wet gas in at 60°.

Heat Out: Residue (19.1 mol wt.): (31,700)(328)=10,400,000 Btu/hr.
Heat Out: Absorber Material (39.0 mol wt.): (10,700)(153)=1,640,000 Btu/hr.
Total Out: ... 12,040,000 Btu/hr.
Heat In: Wet Gas (21.9 mol wt.): (42,400)(301)=12,770,000 Btu/hr.
Heat In: Cool lean oil, 90 to 70°: (171.8)(180)(10)=309,000 Btu/hr.
Total In: ....= 13,079,000 Btu/hr.

The oil chilling load is therefore 13,079,000−12,040,000=1,039,000 Btu/hr.

The total refrigeration load may be summed as follows:

Oil Chillers	1,039,000
Gas Chillers	1,730,000
De-ethanizer Condenser	1,150,000
Total load, Btu/hr.	3,919,000

which is equivalent to 327 tons of refrigeration. Next determine the refrigeration horsepower.

Assume that propane evaporates at 50° (91.8 psia.) in the chillers and condenses at 100° (187.0 psia.) at the accumulator. We can ignore the small liquid stream to the propane scrubber. Enthalpies are obtained from a propane Molliere diagram.[3]

Using a 25° temperature approach in the propane exchanger, terminal conditions for the exchanger may be computed as:

Liquid: 100°→81°
Vapor: 75°←50°

At the chillers:
Enthalpy, sat. vapor @ 50° =290.8 Btu/lb.
Enthalpy, liquid @ 81° =155.1
Difference =135.7 Btu/lb.

or the total propane evaporated in the chillers and condensers is: (3,919,000)/(135.7)=28,900 lbs./hr., or (28,900)/(44.1)(110)=5.96 million SCFD of propane vapor.

Allowing a 7 psi. drop from the evaporator to the compressor suction and a 5 psi. drop from the compressor discharge to the accumulator, the compression ratio will be (187.5+5)/(91.8−7)=2.26. The "n" value for propane under these conditions is approximately 1.15; so, using the

compressor BHP charts[3], we find a requirement of 48.7 BHP per million SCFD. The total refrigeration horsepower required must be corrected for a 75° suction temperature (535° R) and is: (5.96)(48.7)(535)/(520)=299 BHP.

Summing up the calculations:

1) Net recovery rates:
   Propane = 53.3%
   i-Butane = 89.7%
   n-Butane = 94.1%
2) Recompressors: —300 BHP
3) Refrigeration load: 327 tons, requiring 299 BHP.

It would be recommended that two 300 BPH compressors be installed, the load on each machine being equally divided between recompression and refrigeration.

A final comment: It should be kept in mind that there are several possible ways of handling the large quantity of surge tank vapors which result at high extraction rates: recompression to the de-ethanizer is only one method. But regardless of whether these vapors are recycled to a low-pressure reabsorber, or recompressed to a high-pressure reabsorber, etc.; handling them is a serious problem. These vapors have the effect of increasing the plant investment in absorption oil equipment, boilers, and/or compressors, depending upon the manner in which they are handled.

Two general alternatives which will reduce surge tank vapors become economical at high extraction rates. These are 1) the installation of a rich oil de-ethanizer, or 2) the use of multi-stage absorption oil distillation. The first method has been discussed in the preceding articles in this series. The second method will be the subject of those to follow.

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(1) Kirkbride, C. G., *Pet. Refr.*, 23, 321, (1944), and Bolles, W. L., *Pet. Refr.*, Dec., 1946.
(2) Sherwood, T. L., *"Absorption and Extraction"*, Chap. IV, McGraw-Hill, 1937.
(3) "Natural Gasoline Supply Men's Association Technical Manual," 1946.
(4) Kremser, A., *National Petroleum News*, 22, No. 21, p. 42 (May 21, 1930). Souders, M., Selheimer, C. W., and Brown, G. G., *Ind. & Eng. Chem.*, 24, 517 (1932).

Pressure Relieving Systems

Reprints have been prepared of the series of articles on "Design and Construction of Pressure Relieving Systems" which appeared in the July, August and September, 1948, issues of PETROLEUM PROCESSING. A limited number are available for distribution and single copies will be sent without charge to readers requesting them.

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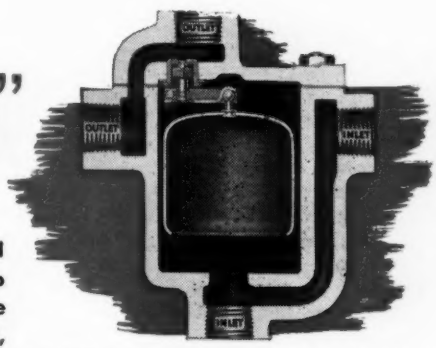

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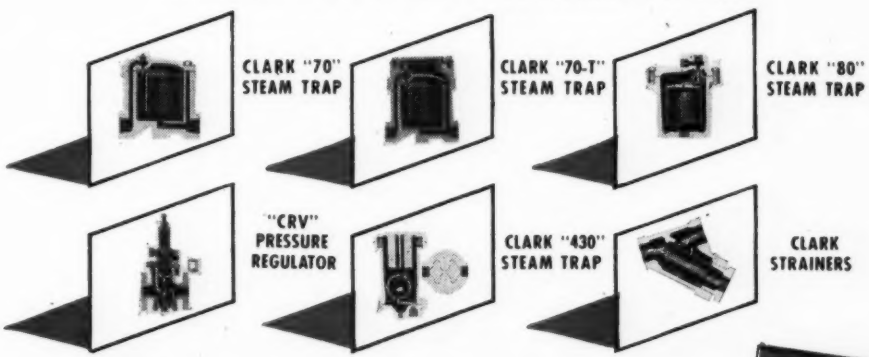

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Hypersorption as Applied to Natural Gasoline Processing Is NGAA Topic

REPORTS ON THE WORK of important technical committees, and papers describing new developments in the natural gasoline and cycling plant industries, make up the program for the 28th Annual Convention of the Natural Gasoline Assn. of America, in Fort Worth, April 20-22.

The adaptation of the Hypersorption process to natural gasoline and cycling plant operations will be discussed by technologists of the Union Oil Co. of California. This process for the recovery of hydrocarbons from gas streams by adsorption by a moving bed of activated charcoal is now being used commercially for the recovery of ethylene of high purity, and it is said to be a practical means for achieving a high rate of recovery of propane from natural gas.

Technical committee reports will be presented at the first session of the convention. "Modifications in LPG Test Methods," by H. A. Montgomery, Warren Petroleum Corp., Houston, chairman of the Technical Committee will constitute the first public mention of actual and contemplated revisions in official NGAA test methods for liquefied petroleum gases.

Following this will be a report of the Fractional Analysis committee, given by A. J. Miller, Phillips Petroleum Co., Bartlesville, and entitled "The Accuracy of Low Temperature Fractional Analysis of Liquid Hydrocarbon Mixtures." This report discusses results obtained in an NGAA-sponsored project, in which 56 laboratories of 34 oil companies and six commercial laboratories are analyzing prepared liquid samples whose exact composition is known only to the blenders.

The next scheduled report is that of the Gas Testing committee of which W. H. Vaughn, Tide Water Associated Oil Co., Houston, is chairman. This will review studies now being made of various physical tests currently used to determine the liquefiable hydrocarbon content of field gases.

"Testing for Sulfur Compounds in Liquefied Petroleum Gases", by J. L. Thompson, Lone Star Producing Co., Dallas, will report results obtained in an NGAA-sponsored research project at the University of Texas to find methods for determining the amount and corrosivity of sulfur compounds in LP gases.

The annual report to the industry on the cooperative research program, now in its fifth year to determine causes and cures of gas condensate well corrosion, will be given by W. H. Stewart, Sun Oil Co., Beaumont, Texas. His report, "Cures for Corrosion in Gas-Condensate Wells," will present specific recommendations for alleviating this destructive corrosion.

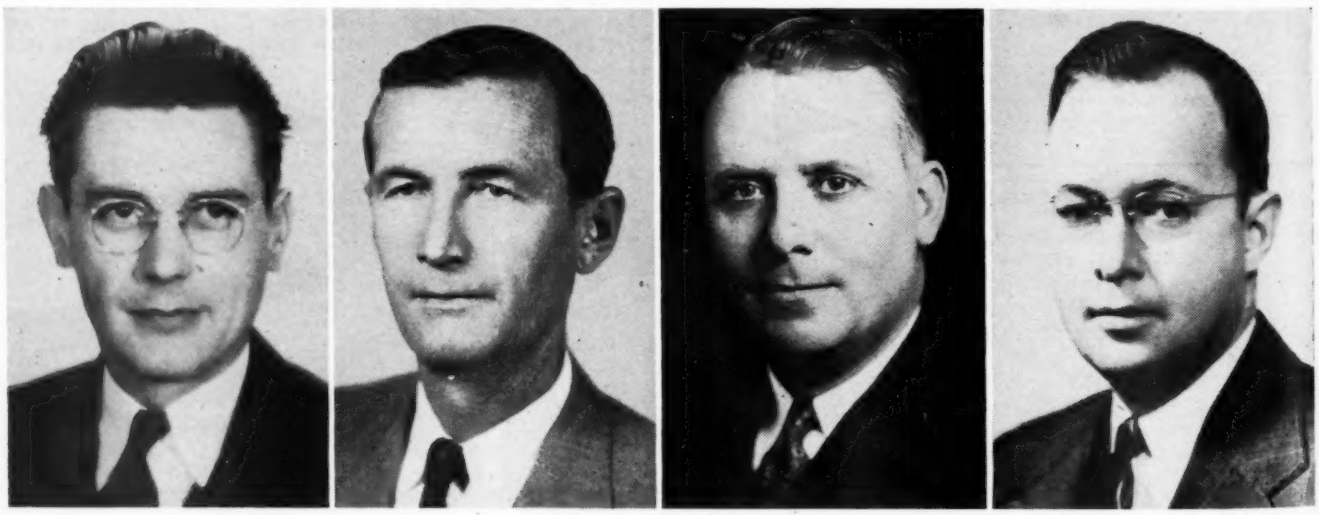
General technical sessions will commence April 21. Ralph Hook, Cotton Valley Operators Committee, Cotton Valley, La. will present a paper entitled "The Predictions and the Actual Results at Cotton Valley." This is the story of what has happened in the reservoir in this great unitized high pressure cycling operation in the last 10 years.

"Hypersorption", by Dr. Clyde Berg and R. G. Fairfield, Union Oil Co. of California, Los Angeles, describes the application of this new process in natural gasoline and cycling operations. "Training Men for the Next Highest Job," by J. C. Harris, Stanolind Oil & Gas Co., Tulsa, will describe the results obtained with a sound program of training at plants and in the field. Details of the program will be presented.

The afternoon session April 21 will feature "Trends of the Times," an address by Richard Wagner, president, The Chicago Corp., Chicago. The reaction of business to the uncertainties and rulings of national regulatory bodies and the effects on our national economy will be considered.

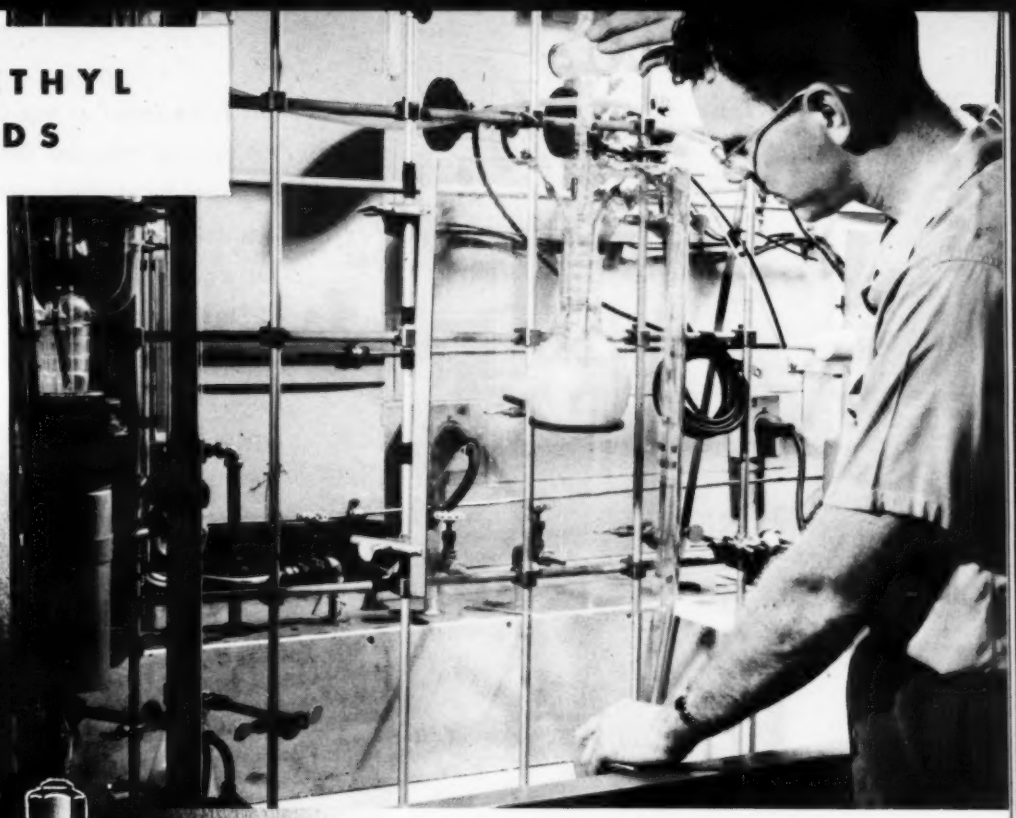
The final technical paper will be delivered by C. H. Van Hartesveldt, Thompson Vita-Meter Corp., Cleveland, "Progress Report on Anti-Detonant Injection in Automotive Engines."

For the sixth consecutive year the entire session April 22 will be given over to the now-famous "Information Please" program. Here 14 experts in a number of fields will be subjected to organized questioning by the audience. It is a forum for executives and technical men alike, in which processing, production and operating trends and problems in the natural gasoline and cycling industries will be discussed.

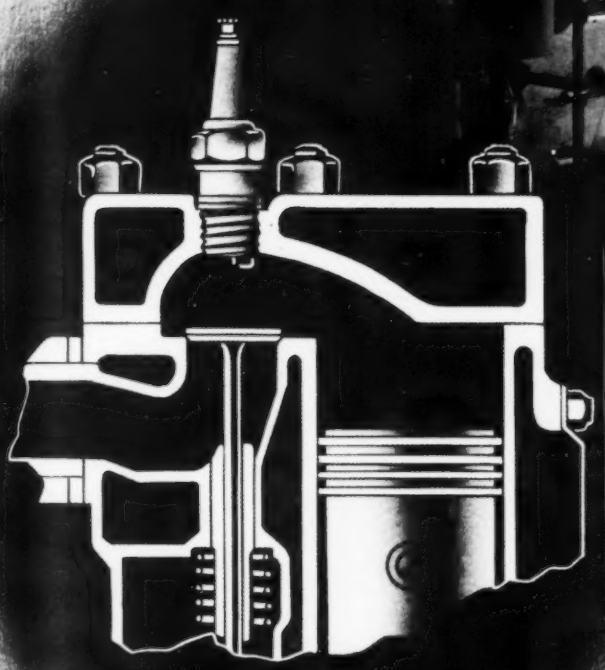


Speakers at the NGAA convention: H. A. Montgomery, Warren Petroleum Corp., Houston; W. H. Stewart, Sun Oil Co., Beaumont, Texas; Richard Wagner, president, The Chicago Corp., Chicago; C. H. Van Hartesveldt, Thompson Vita-Meter Corp., Cleveland

DU PONT TETRAETHYL LEAD COMPOUNDS



The chemical laboratory contributes much helpful data on these investigations. Here, rates of sublimation are being measured in connection with combustion chamber deposit studies.



Du Pont Research

At Work on the Problem of Engine Deposits

Du Pont research on tetraethyl lead and other anti-knock agents is aimed at improving fuel performance and fuel utilization. A vital phase of this research is learning more about how fuels behave inside the combustion chamber. One such basic study is devoted to an investigation of engine deposits.

Although much work has been done on this subject, there is still a great deal to learn about the factors affecting deposit formation, as well as the mechanism by which these deposits affect combustion.

Fuels, lubricants, design, operation—these and other variables which can affect deposits are all being investigated, working toward reduction of deposit formation. This is another example of Du Pont research working on problems of interest to every refiner—research to help you create better fuels, for today and for the future.

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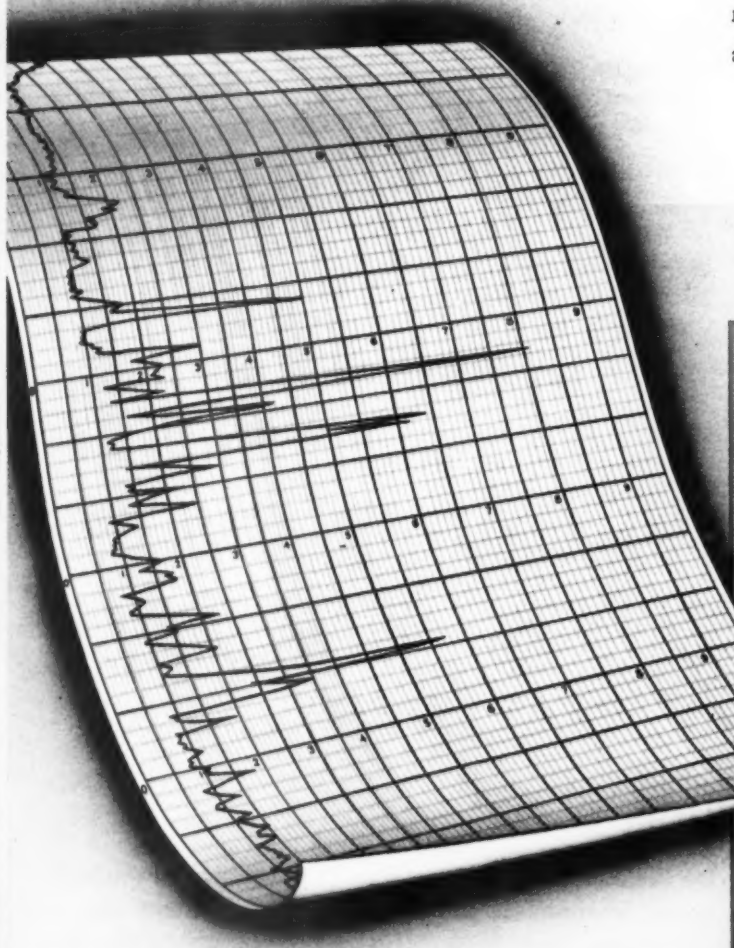

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Auxiliary Reactor Desulfurizes Light Oils from Crude Flashing

AN ENTIRELY NEW MEANS for handling sulfur compounds in the processing of high-sulfur crudes has been installed in the new refinery of Continental Oil Co., at Billings, Mont., which is scheduled for completion in October.

This consists of a secondary reactor operated in connection with the otherwise conventional fluid cracking unit, through which light oils from the crude flash tower flow as a vapor for desulfurization. The desulfurizing reactor, while of the same general design as the conventional fluid reactor and using the same type catalyst, is much smaller and will be operated at a lower temperature. One regenerator will serve both the desulfurizer and the conventional reactor of the fluid unit.

New Approach to Old Problem

The light oils given this desulfurizing treatment will amount to about 47% of the crude charge, it is stated. "This method of eliminating the boogie factor in processing high-sulfur crudes is a new approach to an old problem," states a company announcement on the new refinery.

The Continental refinery, of design charge capacity of 7555 b/sd, will process a high-sulfur (2.2 wt.%), low-gravity (28 deg. API) crude blend consisting of 60% of Elk Basin crude of 29.6 API gravity and 40% of light Frannie crude of 26.5 API gravity. Continental has had production in these fields for some years, which has previously been sold to Carter Oil Co. and to Standard of Indiana.

Corrosion resistant tower linings are being used in many units as a means for protection from the sulfur compounds in the oils processed. A design innovation has been worked out in connection with the installation of the clad sheets in that only one seam weld is required.

A light sheet of 11-13 chrome steel or similar alloy is fused at the mill to a heavier sheet of steel to provide strength in making the clad materials. The bimetallic sheet can then be fabricated as though it were a solid sheet of corrosion resistant metal. This type of material has been used in making all of the larger equipment, the company states, with a sizable saving in fabrication costs as compared to lining the vessels in the customary manner. Following is a general description of the Billings refinery and its proposed operations as given out by the Continental Oil Co.:

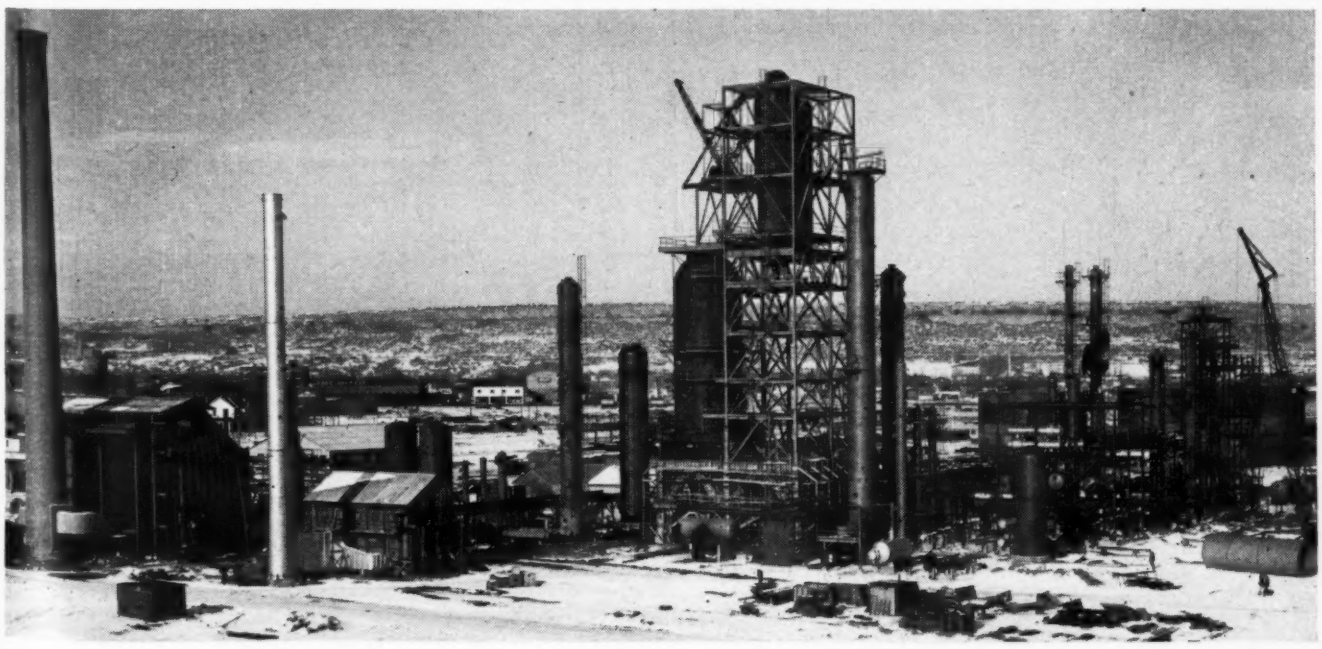
The flow plan as shown in Fig. 1 calls for crude to pass through conventional heat exchange equipment and a large oil heater into a single flash tower at 800° F. From this primary tower all light oils through 600° F. end point Diesel oil will flow as a vapor through the desulfurizing reactor, then to a single fractionator. The latter tower will produce a 250° F. end point product overhead, which is subsequently stripped of butanes and lighter in a stripper stabilizer.

Operation of Desulfurizer

Four strippers are provided for side stream distillate cuts from the secondary crude tower. Part of the heavy side cuts and all of the bottoms containing catalyst fines will be returned to the catalytic cracker. The desulfurizer will operate at about 700° F. and will circulate about 25 tons an hour of silica magnesia type catalyst.

An unstripped virgin gas oil side stream comprising 15% of the crude charge will be taken from the primary crude tower for a catalytic cracking charge.

The remaining 38% bottoms stream from the primary crude tower will flow directly into the propane



General view of Continental Oil Co.'s Billings refinery. Left to right, brick stack and two boilers, crude heater with metal stack, deasphalting tower, catalytic cracking unit, gas recovery plant

deasphalting unit. Here propane, at some 17,000 b/d or a 5.7 ratio to charge, will separate about 2000 b/d of virgin gas oil from the 1000 b/d of asphalt in the 3000 b/d of topped crude. In order to keep the propane liquefied, the treating tower will operate at about 600 lbs. pressure. Two liquid phases will exist in this tower; the upper phase will contain the lighter gravity mixture of gas oil in solution in the bulk of the propane; the lower phase in the bottom of the tower will be asphalt containing a small amount of propane.

The tower top will be controlled at 260° F. by steam flowing through 8 internal coils and the topped crude feed entering near the top. The tower bottom will be maintained at 160° F. by controlling the temperature of the propane streams as they enter the tower at three points near the bottom. After leaving the treating tower the top or raffinate stream of gas oil will be stripped of propane in three successive towers operating at 300, 200 and 5 lbs., then will flow to the caltalytic cracker.

The asphalt bottom stream will flow through the only other oil heater, a small vertical furnace to its 200-lb. and 5-lb. strippers. The asphalt leaving the 5-lb. stripper will either be sold as such, or blended with cycle stock to fuel oil specifications. The propane vapors from the 5-lb. stripper will be compressed to 250 lbs. and join the other overhead streams. These vapors will then be condensed and recirculated.

Two Reactors in Fluid Unit

The fluid cracking unit is of conventional design except for the second reactor, the desulfurizer. One regenerator, 23 x 50 ft., will operate with both reactors. Catalyst circulation through the desulfurizer will be at the rate of 25 tons an hour, and through the catalytic cracking reactor at the rate of 500 tons per hour.

Initial catalyst charge will be 175 tons of the silica-magnesia type. Feed to the catalytic cracker will consist of about 2000 b/d of heavy gas oil from the deasphalter, 1100 b/d of unstripped virgin gas oil from the primary crude tower and 650 b/d from the secondary crude tower, making a total fresh feed of 3750 b/d. Total case charge will be 8550 b/d, including the 4800 b/d of recycle oil. The reactor temperature will be 900° F. The structure for this unit is 150 ft. in height.

The vapor recovery system will recover the propane-butane fraction from all plant gases as feed for the catalytic polymerization unit. A novel feature here is the double contactor tower system used in the H_2S removal unit. The vapor from the first stage compression discharge drum will be contacted with diethanolamine solution in one tower, then compressed through the second stage to the final 260 lbs. pressure. Liquid from the first stage discharge drum will be contacted with the amine in a second tower, then will rejoin the vapors from the second compression stage before entering the fractionators.

The catalytic polymerization unit and after fractionators are of the conventional type for recovery of LPG propane-butane and stabilized catalytic polymerization gasoline. Two tubular reactors will be employed, using a steam generating system for temperature control. The desulfurized straight-run gasoline and

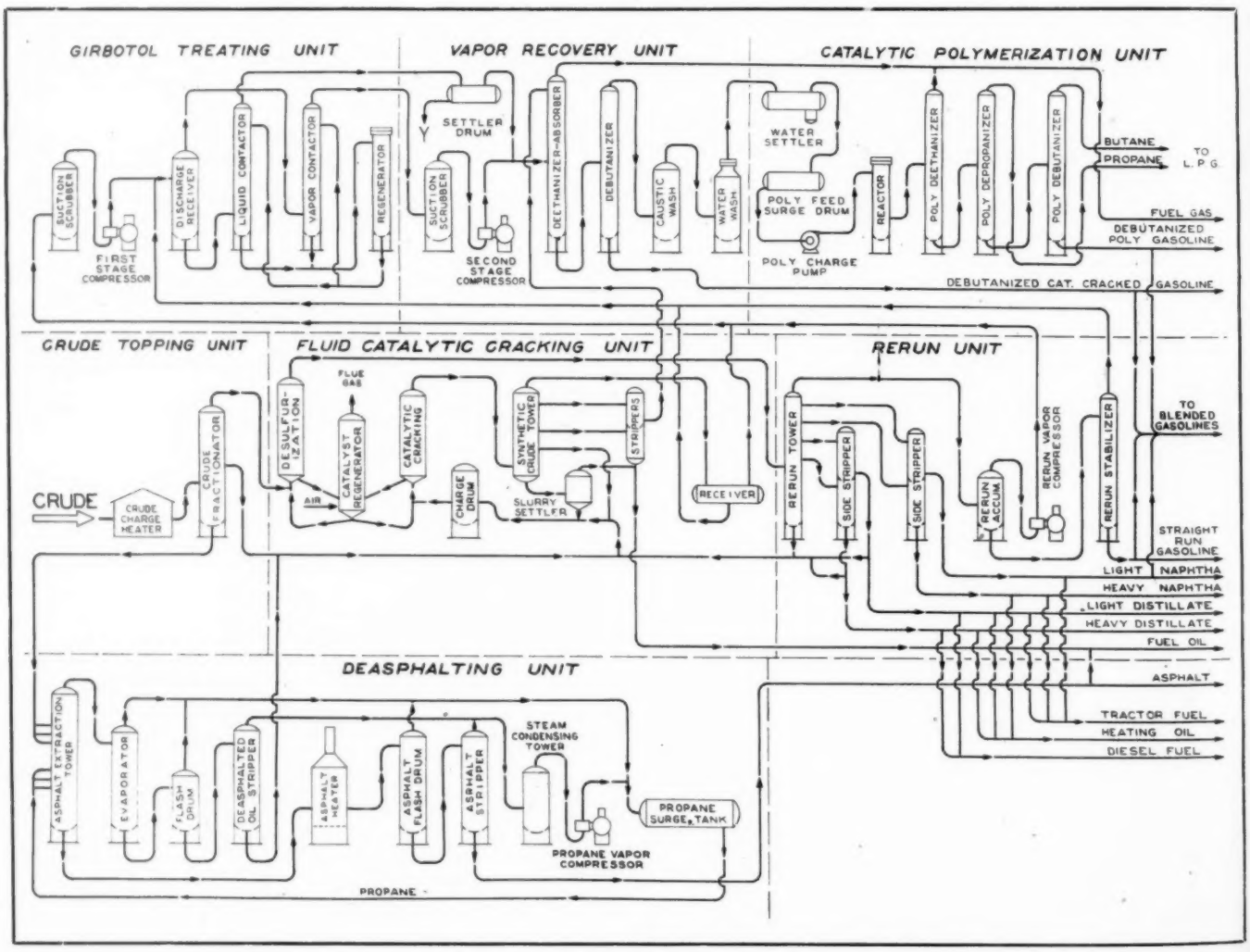


Fig. 1—Simplified flow diagram of Continental Oil Co.'s new Billings, Mont., refinery

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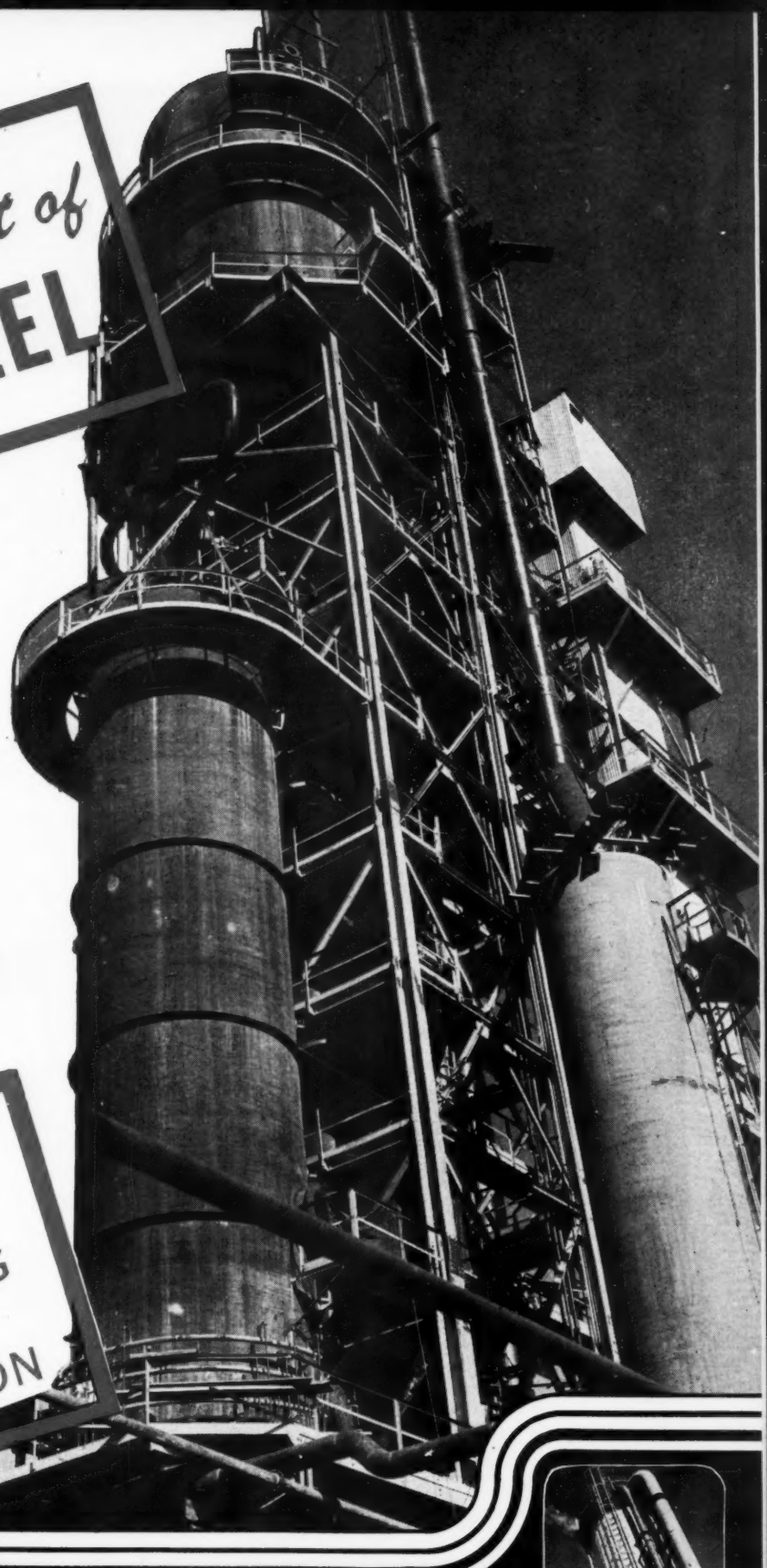

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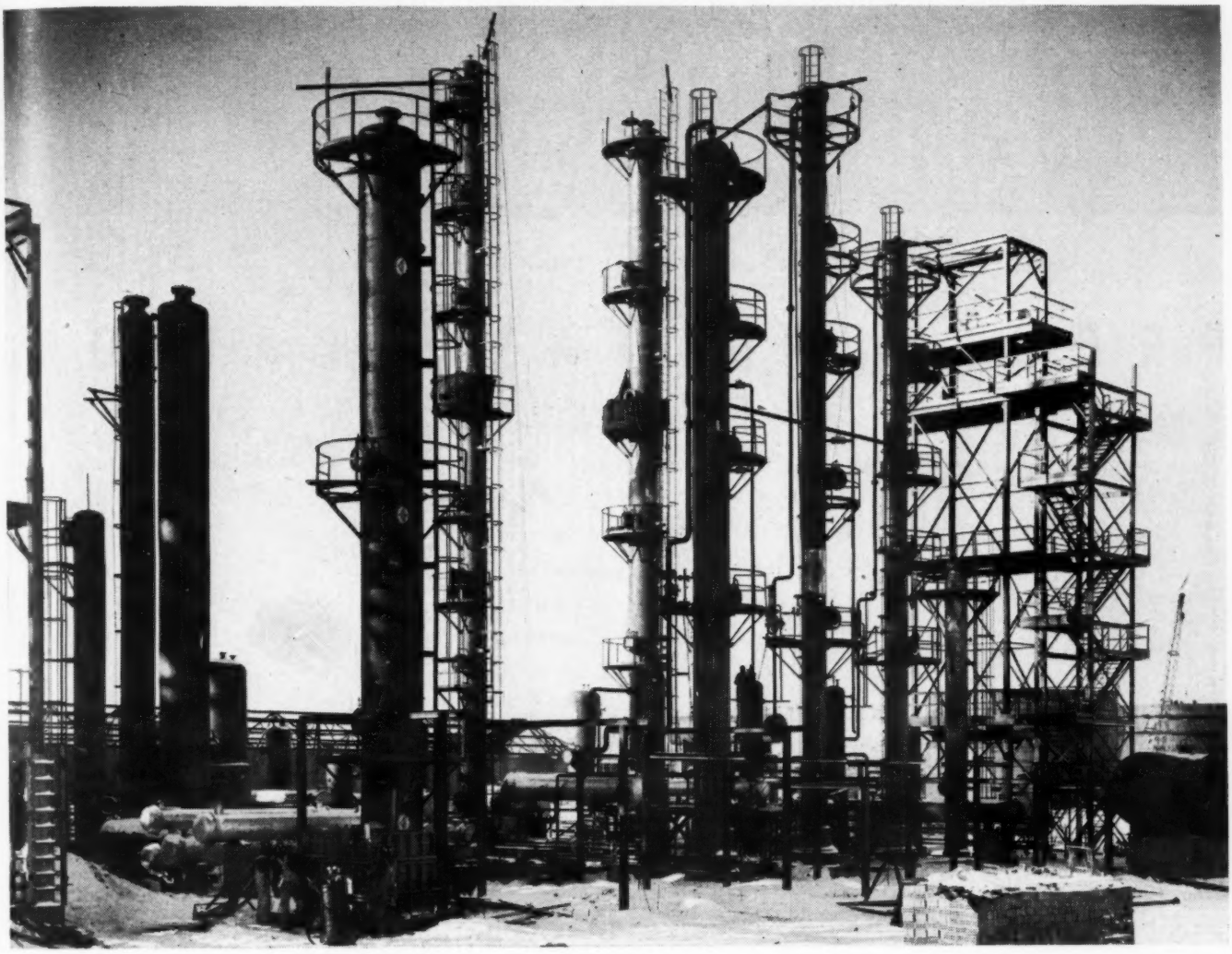

Detailed view of the gas recovery unit at the Billings refinery. At left, feed preparation towers; in center, after-fractionators for liquid petroleum products and stabilized polymer gasoline; right, structure for catalytic polymerization cases

catalytic gasoline will be sweetened in a treating unit rated at 4750 b/d capacity. The butanes will be treated in a twin-case 500-b/d unit. Distillates will be doctor-sweetened.

Total tankage of 438,000 bbls. is being provided for finished and intermediate storage, in 30 tanks. Included in this group are five 500-bbl. LPG tanks, a 10,000-bbl. spheroid for casinghead, a 120,000-bbl. base gasoline tank and the usual other tanks. Storage is also provided for 10,000 gals. of sulfuric acid and 12,000 gals. of caustic. Floating roof tanks are being provided for gasoline storage.

Steam for the plant will be produced in 175-lb. steam generators on the catalytic cracker and by two 650-lb. pressure, 90,000 pound-per-hour boilers. The 650-lb. steam will be expanded to 175 lbs. and 40 lbs. through the drivers on the boiler fans, water pumps and air turbo blower on the catalytic cracking unit. The 175-lb. steam will be expanded through other drivers to feed the 40-lb. and 20-lb. systems. Process heating will be done with 175-lb. and 40-lb. steam. Forty-pound steam will be used for process stripping. Utility heating will be done with 20-lb. steam. Condensate will be returned through a high pressure hot system and low pressure cold system.

Yields from Crude

The Billings refinery is designed to produce from the crude charged approximately 58% of 10-lb. Reid vapor pressure gasoline, with clear unleaded octanes of 73.5 Motor Method and 80 Research Method. Design yields of other products are:

LPG propane- butane	3.5%
Middle distillates	15.0%
Fuel oil and asphalt	22.0%

Situated along the west side of the new Billings refinery will be a truck loading rack which will have a capacity for loading four transport trucks simultaneously. The tank car rack, in the same area, will have 12 double-spots. In the same section will be the marketing warehouse and mechanical offices and the refinery office.

The operating units are located in the approximate center of the refinery site, which covers 118 acres near the Yellowstone river. Two 120,000-bbl. crude tanks, the flare and the water cooling tower are south of the operating area.

The oil separator is located to the east of the units, toward the river. To the north are the treating systems, the LPG tanks, rundown, blending and finished product storage tanks. Sufficient space has been reserved around this equipment for expansion and, in fact, the 118-acre site provides room for expansion of all sections of the refinery.

Construction of the refinery, which will cost $9,500,000, is by the Jones and Laughlin Co. as the major contractor. The Chicago Bridge and Iron Co. is building the tanks.

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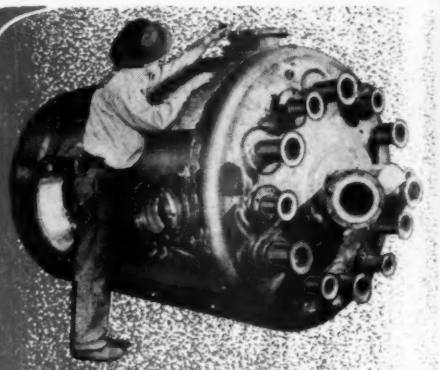

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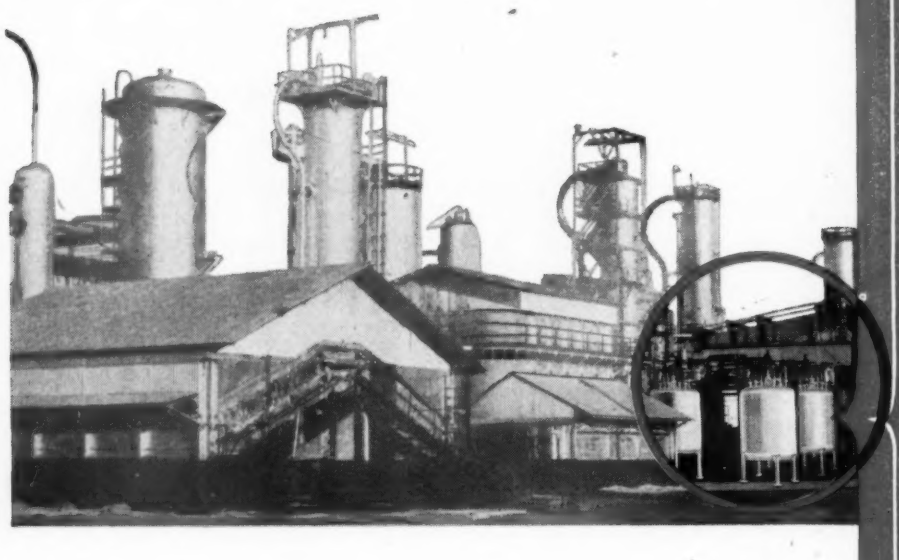

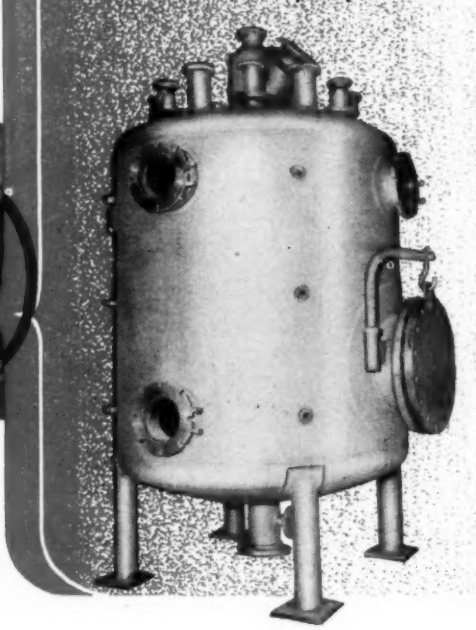

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MODERN SOLVENT REFINING OF LUBRICATING OILS

Article 5—Solvent Extraction Processes

By V. A. KALICHEVSKY

Consulting Chemical Engineer, Magnolia Petroleum Co., Beaumont

Operating features of individual solvent processes are described. Maintenance of the optimum temperature gradient for the particular charge is essential to efficient operation of the furfural and phenol processes. Benzol is used as an auxiliary solvent with sulfur dioxide to overcome its low solvent power. The Duo-Sol process combines selective solvent refining and deasphalting in a single step. When specifications for the first grade product are severe, recovery of second grade products can be advantageously made a part of selective solvent extractions. This article concludes the present series by Dr. Kalichevsky.

Furfural Process

FURFURAL HAS A RELATIVELY low boiling point of 323° F., and may be used for extracting comparatively light petroleum fractions as well as the heavy ones, thus increasing the range of its usefulness. Its miscibility temperature with the various oil stocks is generally high, which is also an asset because the solvent can be applied to undewaxed oils, and contacts between the oil and solvent are made at elevated temperature when viscosities are low. This facilitates mixing and settling.

Specific gravity of furfural is 1.1622 at 68° F., which insures a substantial gravity differential between the extract and raffinate phases. Furfural has a slight tendency to oxidize but at the temperatures employed in normal plant operations no difficulties are encountered, although in some instances it might be desirable to de-aerate the feed stock before it is charged to the system.

Furfural is separated from the oil by distillation. It forms a constant boiling mixture with water. However, the difference in composition of this mixture and that of furfural condensate saturated with water is sufficiently great to make use of it for separating the two substances. The solvent is freed from the constant boiling mixture in one column while water from the constant boiling mixture is removed in another column. The two phases obtained on liquefaction of the constant boiling mixture in either still are redistilled in the respective columns to secure the final separation of the two components.

Treating temperatures vary from 100° F. to 250° F. Mid-Continent oils are often extracted at about 200° F. Furfural is distilled from the oil at about 450° F. but it is claimed that temperatures up to 550° F. may be used without seriously affecting the solvent. Contacting between solvent and oil is done in counterflow towers. Towers are packed with about 20 feet of Raschig rings with redistributing sections at approximately each four feet of packed tower space. Charge rates average about 35 gallons of oil per hour per square foot of overall tower cross-sectional area, although rates as high as 70 gallons or even more are often possible.

High velocities are desirable in order to improve the extraction efficiency provided they do not exceed the optimum when entrainment becomes excessive. This optimum varies with the nature of the stock and the extraction temperature. As with all other refining solvents, high extraction temperatures and the use of correspondingly smaller volumes of solvents produce oils of about the same characteristics as those secured at low extraction temperatures but with large volumes of solvents, although the yields may be slightly less. This is due to a certain factor of safety in the design of commercial equipment with respect to the number of available contact stages or their equivalents.

In practice, extraction towers are operated by maintaining a temperature gradient of 20-50° F. between the top and bottom. A temperature gradient is sometimes maintained also in stage systems. This is done in order to recirculate additional quantities of oil within the system by internal refluxing. Refluxing increases the extraction efficiency when the height of the tower or the number of extraction stages are insufficient to secure optimum separation between the two phases. Temperature gradient is of little or no benefit if the number of equivalent extraction stages is above a certain maximum when separation between the desirable and undesirable oil constituents is fairly complete and the gain obtained by introducing additional extraction stages becomes negligible.

Reeves[25] demonstrated that each installation should be operated at an optimum temperature gradient which varies also with the nature of charge stock and extraction temperature. If the temperature gradient is above or below such optimum the extraction efficiency is impaired. The best temperature gradient may be estimated employing the previously described extraction equations, but the error involved in such calculations may be appreciable. For this reason the usual method of determining it is by experimentation.

Efficiency of extraction may be improved also by recirculating a portion of the extract phase which can be injected with the feed stock. The extract phase leaving the tower is passed through a settling tank where some of the oil separates on cooling. This oil consists of higher viscosity index constituents than those left in solvent solution and if the equipment is not very efficient, some of these constituents belong to the raffinate and not to the extract. By passing them again through the tower the yield of raffinate may be increased. Recirculation of some of the raffinate phase may also be resorted to. In the latter case the raffinate phase is allowed to cool and settle and the solvent layer is injected into the fresh solvent feed.

All these methods may or may not

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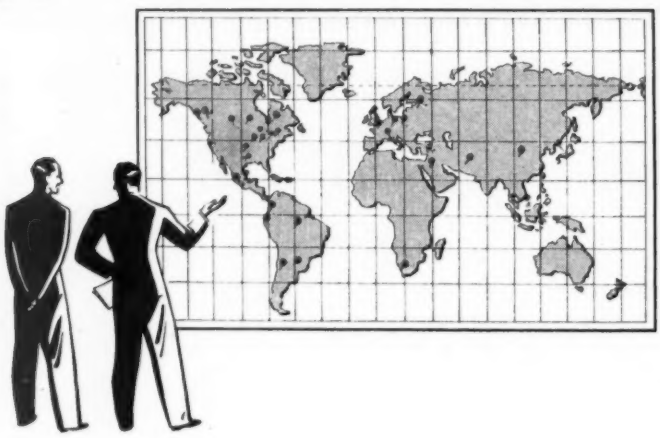

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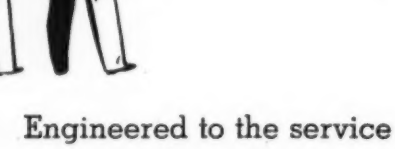

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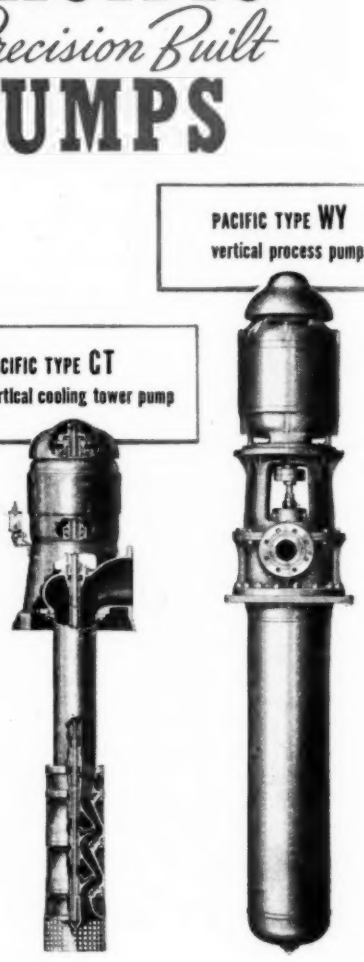

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be helpful in improving operation of the extraction systems for the reasons already mentioned. No benefits can be expected if ultimate extraction conditions, i.e., maximum possible separation between the desirable and undesirable oil constituents is already attained. This can always be ascertained by laboratory extractions if proper equipment is available.

Sometimes imaginary improvements in plant yields are recorded because of the failure to recognize very small deterioration in the quality of raffinate which may occur from the existing tolerances in reporting plant results. This must be taken into account in scrutinizing the experimental data so as to make suitable corrections in final conclusions.

Phenol Process

Phenol has a boiling point of 361° F. Its melting point is 105.6° F. but is easily lowered by the addition of small quantities of water or by the presence of impurities. Its miscibility temperature with the various oil stocks is fairly high although somewhat lower than for furfural. Specific gravity is 1.072 at 68° F.

Extractions are usually done in counterflow towers equipped with plates. In modern plants the charge stock is preheated and first brought in contact with a water solution of phenol in an absorption tower where phenol is dissolved by the oil in preference to water. The water solution of phenol is the constant boiling mixture obtained on distillation. The extraction method is used for separating phenol from water instead of the redistillation method described under the furfural process because the difference in the composition of the constant boiling point mixture and the condensate is small.

The oil is then passed through the extraction tower where it is contacted with anhydrous phenol. The same as with furfural the tower contains two distinct phases. The upper portion occupying about 30% of the tower height has raffinate as the continuous phase, while in the lower portion the continuous phase is represented by the phenol extract. Some of the constant boiling mixture consisting of 11% phenol and 89% water may be added at the bottom of the tower to increase internal refluxing and raise the miscibility temperature for the reasons explained further below.

Extraction temperatures are adjusted for individual stocks. In general, distillate stocks require the top temperature of about 150-155° F. and the bottom temperature of about 110° F. Residual stocks are extracted employing a top temperature of about 225-230° F. and the bottom temperature of about 155° F. At these temperatures waxy stocks can be easily handled.

The raffinate contains approximately 20% phenol, which is removed by flashing at 550° F. and stripping the remainder with steam under vacuum. The extract is treated similarly with the exception that it is flashed at about 650° F.

One of the features of the process is the use of water to reduce the solubility of oil in phenol at the tower bottom where the extract phase is removed. Water displaces the high viscosity index constituents that may be present in the extract and thus produces the effect very similar to that obtained by applying viscosity gradient. As it may be noted, both methods of securing internal reflux and of improving tower extraction efficiency are employed in the phenol process. For the reasons already explained the optimum temperature gradient varies with the type of oil processed and the nature of solvent employed. Addition of water to a solvent changes its solvent characteristics and for best results a proper balance should be maintained between the amount of water injected and the temperature gradient used for the individual stocks processed through the plant.

Sulfur Dioxide Process

Sulfur dioxide boils at 14° F. but can be liquefied at ordinary temperatures by applying pressure. Specific gravity of liquid sulfur dioxide at 68° F. is 1.45. Because of its very low boiling point it can be easily removed from the oil by distillation, while its high specific gravity and low viscosity permit an easy separation of the two phases by settling.

Sulfur dioxide was the first solvent employed for extraction of petroleum products. It is very well suited for refining kerosine and light distillates. When it is applied to heavy distillates the selectivity of this solvent remains very high but its solvent power drops off very rapidly. For this reason the quantities of solvent required to remove the undesirable constituents from the heavy oil fractions are commercially prohibitive.

The difficulties encountered with the low solvent power of liquid dioxide can be overcome, however, by diluting it with a solvent which has a very high solvent power though not necessarily a high selectivity. For commercial operations benzol was chosen as such an auxiliary solvent, although many other substances might be used with similar success.

The quantity of benzol employed may be varied with the type of stock treated, thus adjusting selectivity and solvent power of the benzol-liquid sulfur dioxide blends to the particular refinery problems. With single solvents, like furfural or phenol, this flexibility is obtained by varying the temperature. The additional flexibility is necessary in the case of liquid sulfur dioxide because the temperature range within which this substance can be employed is limited on account of its high vapor pressure and similar considerations.

Besides liquid sulfur dioxide-benzol blends, many other mixtures of solvents may be employed. The change in solubility characteristics of such mixtures with composition may be estimated by employing empirical formulas of the type of those already described. For a constant temperature these formulas appear as follows:[26]

$$\text{Log } L = A \log S' \log S'' + B \log S' + C \log S'' + D$$

where L is the fraction of oil dissolved by the solvent, S' and S'' are quantities of respective solvents employed and A, B, C, and D are constants.

Example 5. Coastal distillate was extracted with various blends of benzol and aniline under identical treating conditions. Results were obtained as given in Table 1.

Estimate the fraction of oil dissolved by 0.63 vol. of aniline and 0.88 vol. of benzol per volume of oil charge.

The equation developed from these data assumes the form:

$$\text{Log } L = 0.064 \log A \log B + 0.209 \log A + 0.637 \log B - 0.612$$

From this equation it may be calculated that the fraction of oil dissolved by 0.63 vol. of aniline and 0.88 vol. of benzol per volume of oil charge is 0.21. The experimentally determined fraction dissolved by this blend was 0.22.

Other Solvent Processes

Chlorex and nitrobenzene are other solvents which find application in lubricating oil refining. Their boiling points are 352° F. and 411° F., and their specific gravities are 1.222 and 1.207 at 68° F. respectively.

Both solvents are characterized by high selectivity and high solvent power. They are well adapted for extraction of highly paraffinic stocks although they can be used also on Mid-Continent stocks.

Most chlorex plants employ countercurrent stage extractions but in the more modern plants counterflow towers are used. In stage extractions the floor space may be saved by locating horizontal settling tanks one above the other. The raffinate phase is allowed to gravitate downward

TABLE 1—Extraction of Coastal Distillate with Blends of Benzol and Aniline

Aniline (A) Vol./vol. Oil	Benzene (B) Vol./vol. Oil	Fraction of Oil Dissolved by Solvent (L)
0.50	0.17	0.07
1.33	1.00	0.26
2.00	1.00	0.28
5.00	0.67	0.26

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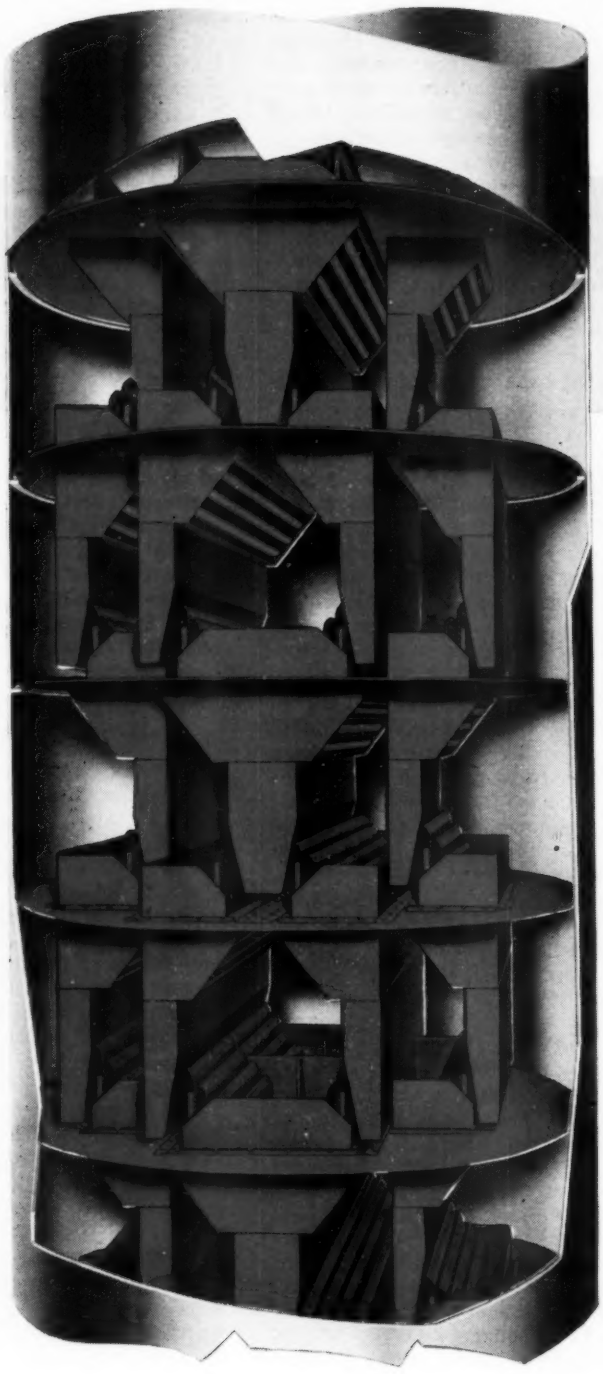

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while the extract phase is pumped upwards in the opposite direction. In refining Pennsylvania oils chlorex is used not only for raising their viscosity index but also for improving the yields from clay percolation filters. Oils of this kind contain very little asphalt and even residual stocks can be refined directly with selective solvents without preliminary deasphalting which is required with all other types of oil.

The nitrobenzene plant employs the "cascade" system for contacting the oil with solvents. The settling chambers are elevated above the ground and the separated layers flow from them to the mixing pumps which transfer the mixtures to the next settling chambers. A 5-stage treating system is used.

Pennsylvania residual stocks are extracted with chlorex at 100° F. to 125° F. while Mid-Continent stocks are extracted at 30° F. to 80° F. Nitrobenzene also requires low extraction temperatures. It is claimed, however, that waxy high pour point oils can be processed by either solvent without formation of emulsions. It is also claimed that nitrobenzene may be used on residual stocks containing asphalt although they may require more clay to improve their color and carbon residue than the deasphalted oils.

Duo-Sol Process

Selective solvents remove from the oil the low viscosity index constituents but only small quantities of the asphaltic substances. If the oil is mixed with propane or other deasphalting solvent at the time it is contacted with selective solvents, these asphaltic substances are forced out of the oil into the extract phase and the two operations are combined in one. Propane is so far superior to all other deasphalting solvents that it is in a class by itself, and thus far, substances proposed as its substitute could never replace it commercially.

However, the choice between selective solvents is somewhat less restricted. These solvents should not be miscible with oil in the presence of propane within reasonable temperature limits. This requirement reduces very considerably the number of selective solvents that can be used for this particular purpose. A mixture of cresylic acids and phenol, commonly referred to as "Selecto" is used commercially in the Duo-Sol process, which is the only one available that combines selective solvent refining and deasphalting in a single step.

From seven to nine extraction stages are normally employed. The oil to be refined is usually introduced two stages from the extract exit and propane and Selecto are fed to the extract and raffinate outgoing stages, respectively. Propane is thus utilized not only as a deasphalting solvent but also for washing the extract from the traces of occluded oil that it may contain before it is discarded from the system.

The solvent to oil ratios are relatively high. Up to 400% wt. Selecto and 400% wt. propane are often required to obtain the desired results and even larger quantities of solvents may be occasionally employed. The treating temperature is somewhat above 120° F. although with some stocks it might be lowered to 90° F. or less.

The description of the process shows that the number of variables involved is greater than in any other selective solvent refining process. Some of these variables are interdependent and their thorough understanding is important for successful operation of a Duo-Sol unit.

Treating temperature is usually maintained a few degrees below the complete miscibility temperature but as close to it as possible in order to insure satisfactory settling by reducing viscosities of the two phases and by keeping as much as possible of wax in solution. The miscibility temperature depends on the nature of charge stock, propane to oil and Selecto to oil ratios and composition of Selecto. Treating temperatures may vary somewhat from one compartment to another but this is done for improving settling characteristics of the mixtures and not for maintaining a temperature gradient.

The composition of Selecto is of considerable importance. At the same temperature level, phenol has less solvent power than cresylic acid and in order to secure similar results the extraction temperatures must be higher with phenol than with cresylic acid. Although high extraction temperatures are generally desirable, their use is limited by the high vapor pressure of propane. The upper temperature limit is therefore determined by the ability of the equipment to withstand pressure. Composition of Selecto is then adjusted so as to permit processing of all the refinery stocks fed to the unit at the highest allowable temperatures.

The relative as well as the absolute quantities of propane and Selecto employed are important for insuring the product quality. If the ratio of propane to Selecto is kept constant, raffinates of increasingly better viscosity index and carbon residue are obtained with an increase in the total solvent to oil ratio. If Selecto to oil ratio is constant and the quantity of propane is the only variable, an increase in the volume of propane results in a lowering of the viscosity index while the carbon residue may or may not show an improvement. Finally, if the propane to oil ratio remains unchanged, the increase in the volume of Selecto improves both viscosity index and carbon residue of the product.[27]

In commercial installations distillation equipment is capable of handling certain fixed quantities of propane and Selecto. For this reason it is customary to keep the propane to Selecto ratio constant and vary mainly the total solvent to oil ratio.

As was already mentioned, Duo-Sol plants have normally, two stages for washing the extract phase with propane and from five to seven Selecto extraction stages. If the plant is operated at high throughput rates and some of the recoverable oil is discarded with the extract because of inadequate washing and settling, the number of propane washing stages might be increased at the expense of extraction stages. However, this should be done only after considerable study because the number of extraction stages left may be insufficient to secure the optimum conditions of extraction.

Occasionally it might be desirable to increase the settling time at some point of the system. This can be done by eliminating a mixing stage and interconnecting two settlers. As this method also affects the overall extraction efficiency, its use is justified only after conducting a certain amount of experimental work. Because of the differences in settling rates between the individual stages, the size of settling chambers is sometimes adjusted for insuring maximum throughput without building oversize equipment for all the extraction stages.

Propane and even Selecto may be added to more than one compartment for improving settling rates and decreasing emulsification, but this is undesirable if maximum utilization of solvent is expected. Recirculation of the Selecto layer which separates from the raffinate phase on cooling is occasionally resorted to in order to raise extraction efficiency.

When the plant is operated at maximum settling capacity, very small variations in pump rates, temperature or quality of charge stock

Correction

In introducing V. A. Kalichevsky, in the December issue of PETROLEUM PROCESSING, as the author of the series of articles "Modern Solvent Refining of Lubricating Oils", he was mentioned as the author of "Chemical Refining of Petroleum". It should have been brought out that Dr. Bert Allen Stagner, consulting and research chemist, was co-author with Kalichevsky of "Chemical Refining of Petroleum".

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may disturb equilibrium and some of the extract phase may become mixed with the raffinate. This contamination might be very small and have no noticeable effect on physical properties of the product except color. The condition may be remedied by slightly reducing the throughput or by raising the extraction temperature, if feasible. If the second method is resorted to without a corresponding adjustment in the solvent to oil ratio, the oil is overtreated because of the increase in the solvent power of the solvent, which might be undesirable.

However, if the adjustment is made, emulsification difficulties might be encountered again as reduction in viscosity of the two layers caused by an increase in treating temperature might be offset by the increase in viscosity resulting from the use of smaller volumes of solvents. The operation of the unit may thus become unbalanced. For this reason a certain degree of caution should be exercised in determining the unit throughput if a smooth and steady operation of settlers is expected.

Calculation of the yield and quality of products obtained in Duo-Sol refining is somewhat complicated because of the presence of two dissimilar solvents, i.e., a precipitant-propane and a selective solvent-Selecto. If the Selecto to oil ratio and composition of Selecto remain constant, variations in yield and quality of raffinate with the change in propane to oil ratio may be estimated by the method described in connection with the deasphalting solvents. If the propane to oil ratio and composition of Selecto are constant, the effect of the volume of Selecto used is approximated in a similar manner, explained under the selective solvent extractions. If composition of Selecto is the only variable, the procedure mentioned for extractions with mixed solvents may be employed. However, no satisfactory method has been developed to unite all the variables into one simple equation which would cover all the variables involved in Duo-Sol refining.

The Duo-Sol process is usually applied to the refining of residual stocks which contain both asphalt and low viscosity index constituents. However, sometimes it is used also for treating distillate stocks or mixtures of residual and distillate stocks. This depends on local refinery problems which vary from one plant to another.

Recovery of Secondary Grade Oils In Selective Solvent Extractions

In preparing very high grade lubricating oils some of the fractions that are satisfactory for the manufacture of lower grade products find their way into the extract. They can be recovered if this is necessary, by re-extracting the extract at less severe treating conditions or by first preparing a raffinate of medium quality and then retreating it more drastically to obtain the lower grade lubricating oil as the secondary extract. In re-treating the extract very mild conditions are necessary because of the highly aromatic nature of the material while in re-treating the raffinate the reverse condition exists. This determines, to a great extent, the selection of plant procedure, as it depends on the available facilities.

The quantity of oil recovered as first and second grade products is subject to variation. The more of the high quality constituents incorporated in the second grade product the higher is its yield because further quantities of lower grade oil fractions can then be incorporated into it without interfering with specifications. For the same reasons, the recovery of second grade oils becomes attractive only when the specifications for the first grade product are very severe, thus resulting in very small recoveries.

Irrespective of occasional claims to the contrary, each crude oil contains only a certain and definite quantity of various constituents. The ultimate recovery of lubricating oil fractions is obtained by employing a variety of solvent refining schemes provided the selection of treating conditions and equipment is carefully chosen. Whenever a further increase in product yield is secured, it should be ascribed to improved operating technique or modernization of installations and not to imaginary causes. For this same reason all processes should be compared under optimum conditions of performance because otherwise incorrect conclusions may be reached which may result in unnecessary expenditure that could be avoided by a careful scrutiny of existing problems.

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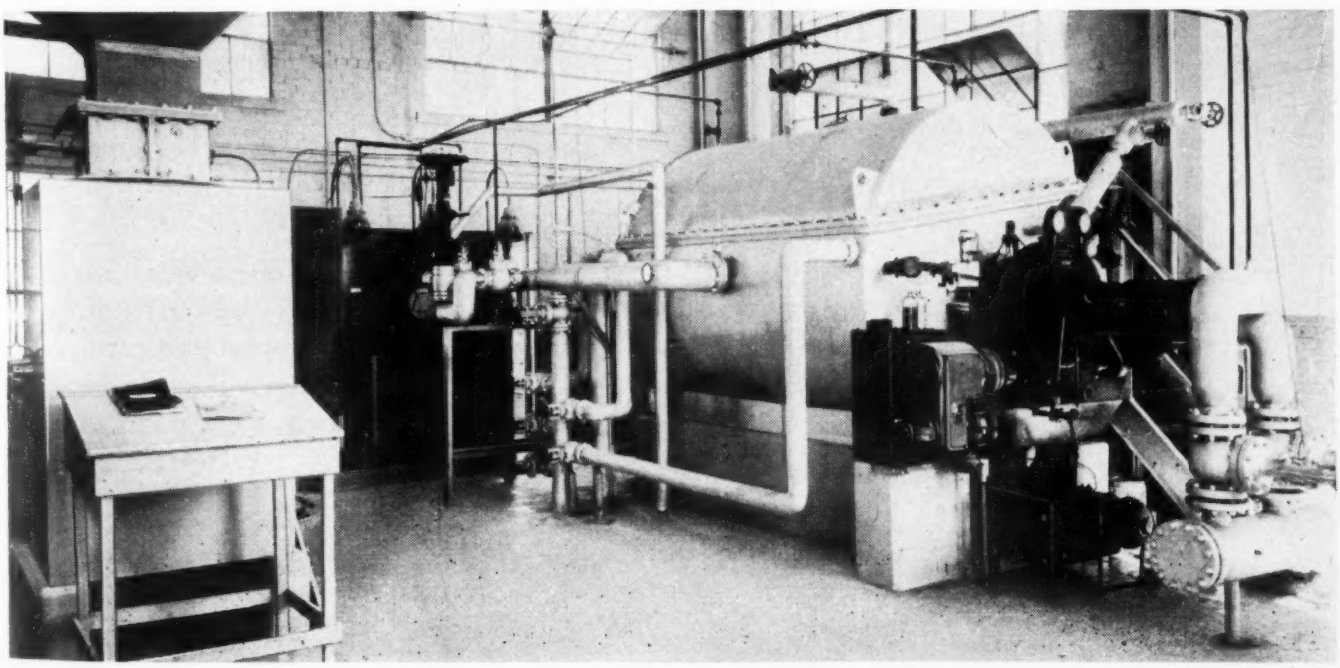
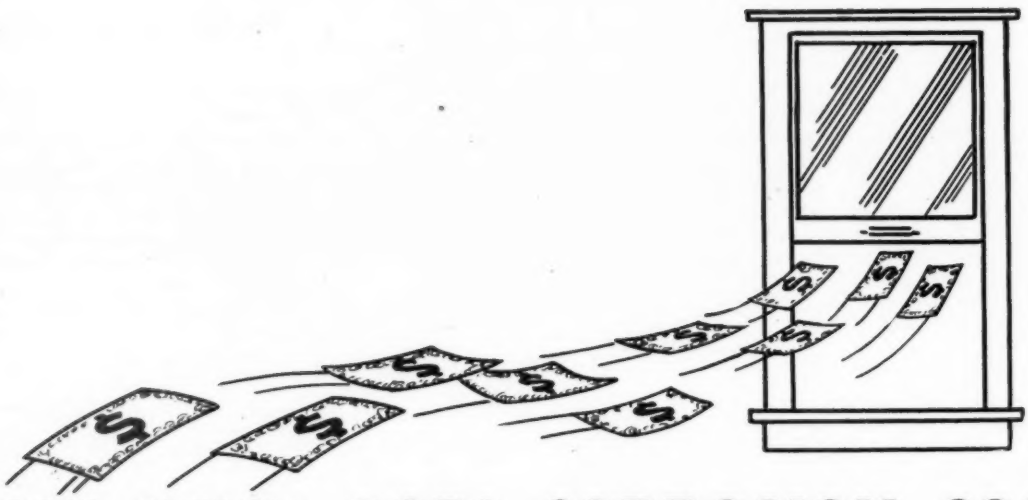


Modern clay contacting plant in lubricating Refinery (Photo courtesy The Lummus Co.)



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Plant Practices

Practical Tips and Ideas for Improving Operations

Shop-built Pressure Tester Has Payout Of Six Months by Man-hour Savings

BUILT from both scrap and new materials for an estimated $500, a "cider press" type pressure tester for valves, fittings, and the like has paid for itself in 6 months in time savings in the maintenance shops of Sinclair Refining Co.'s Marcus Hook refinery.

Until the machine was built, equipment was tested by simply closing one end and connecting the other end to the discharge side of a hydraulic test pump. Because of the odd sizes and great number of fittings to be tested daily, it was often necessary to use considerable ingenuity and many different reducers to make the required connections. The machine is shown in the accompanying photograph.

"H" Beams for Uprights

The upright posts were fabricated from two pieces of 8-in. "H" beam 7 ft. long. Across the top of these, a ¾ x 8 in. plate, 50 in. long, was welded; and on top of this, for extra strength, was welded a piece of 4-in. channel iron. The heavy bed plate shown at the base is 2½ in. thick and 36 in. square. Under this plate, resting on the floor, is a piece of 12-in. pipe with the bottom end closed. The top end of the pipe is welded to the underside of the bed plate.

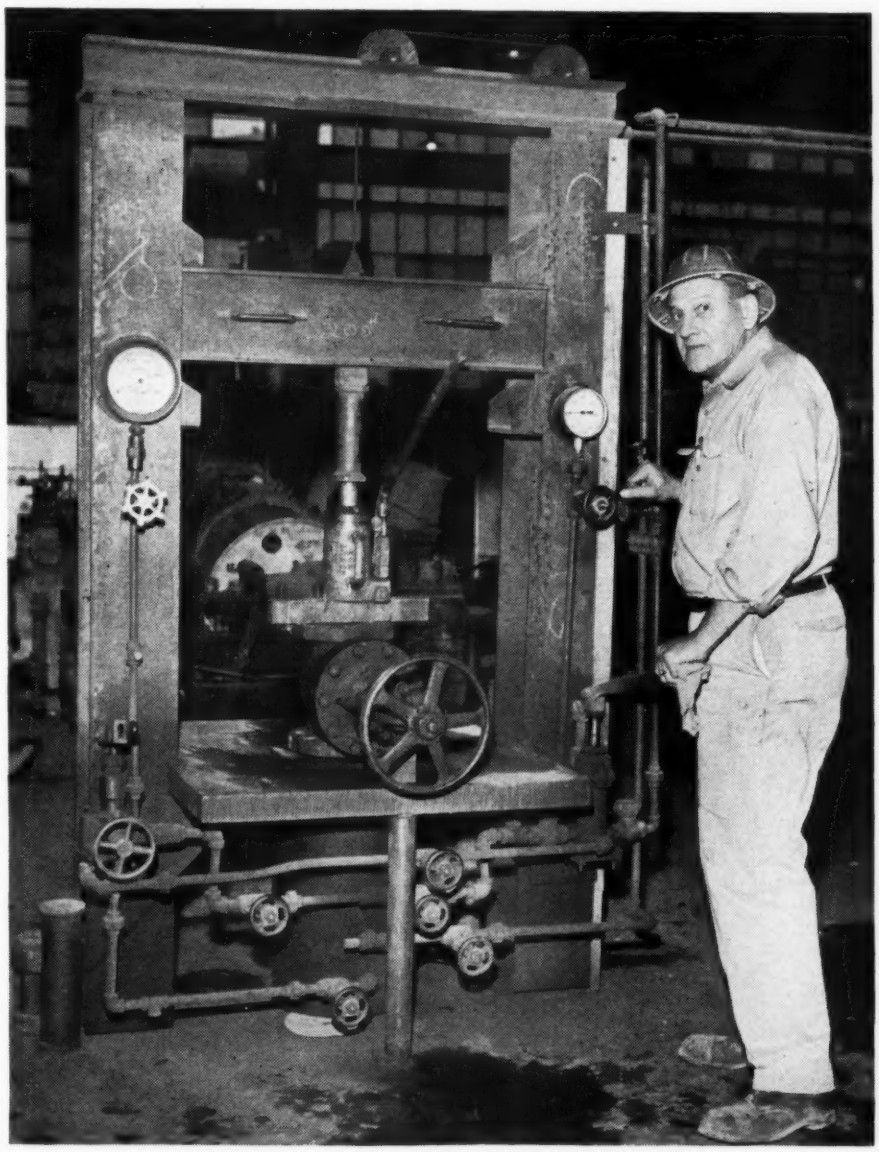
In the center of the bed plate, directly above the center of the 12-in. pipe, a hole is tapped with a ½-in. pipe thread. Around the center of this hole, concentric circles are marked off to aid in centering objects placed on the bed plate for testing.

Uses Counterweight

Between the 7-ft. uprights, and resting between the projecting lugs, is a piece of 8-in. "H" beam 36 in. long. This is fitted with handles and is suspended on wire rope connected to a counterweight for ease in placing it beneath either the upper or lower pair of lugs. The beam serves as a back up plate for the fitting to be tested.

In use, the fitting is placed over the center of the ½-in. hole in the bed plate with a rubber gasket between the face of the fitting and the plate. A bar is then laid across the top of the fitting and a jack is inserted between this bar and the back up "H" beam, additional spacers being used as needed. Sufficient pressure is applied with the jack to force the fitting tightly against the bed plate.

The water valves are then opened: water passes through the 12-in. pipe up into the fitting on test. If it is desired to test a fitting or to test both sides of a valve at the same time for



In the photograph, the operator has begun applying pressure to the gate valve in place on Sinclair's "cider press" testing machine

body leakage, the top flange of the fitting can be sealed by means of a gasket and a blind flange.

In any event, when the fitting has been filled with water, hydraulic pressure is applied by means of either the hand pump on the right or that shown on the left. With the pump on the right, tests to a maximum of 600 psi. can be made, while with the left hand pump, the tests can be run up to 5000 psi. Once the desired test pressure is established, the inspection consists of visual examination of the gage or of the fitting.

The fact that the ½-in. hole in the bed plate has been tapped with standard pipe thread makes possible the use of the machine for testing thermocouple wells and other pieces.

Maintenance on Spheroids Made Safe By Using Mobile Workmen's "Cage"

SANDBLASTING and painting the exterior surface of spherical tanks for the storage of liquefied petroleum gases and the like at the Philadelphia refinery of Atlantic Refining Co., has been made into a fast, safe, and relatively simple operation through the use of a shop-built "cage."

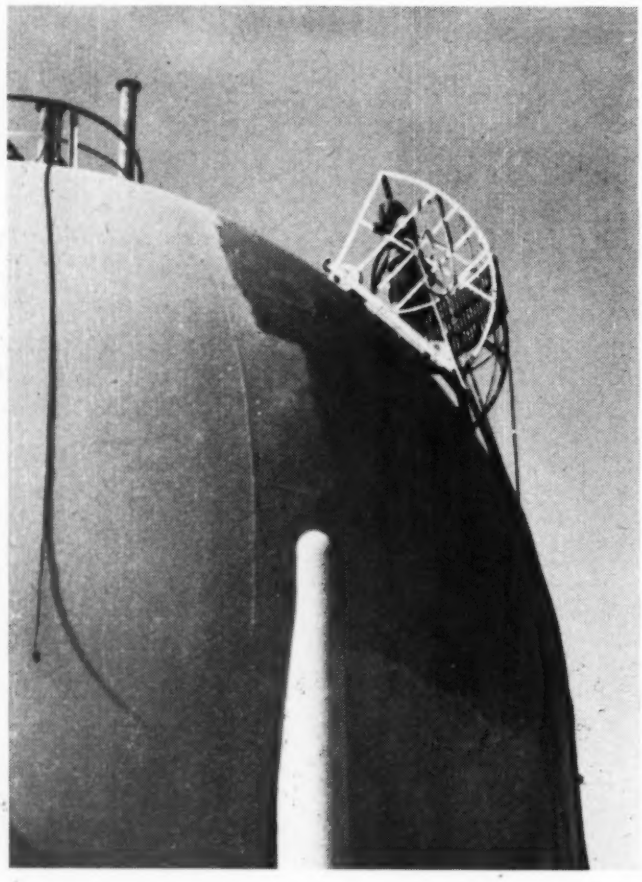
Ordinarily this type of maintenance operation required the time-consuming erection, and subsequent disassembly, of a complex and extensive wooden scaffold. This is no longer necessary when use is made of the cage illustrated in the photograph and in the sketch in Fig. 1.

Constructed chiefly by welding together a frame work of ¼-in. thick flat bars, angles; 4-in. channels; and a small amount of ½-in. plate; the device will accommodate two workmen comfortably. Overall dimensions are: length, 8 ft. 7 in.; height, 5 ft. 5 in.; width, 6 ft. 6 in. It is mounted on four rubber-tired wheels for moving up and down the surface of the tank. The curved grill-work floor insures safe footing and a level platform for operators and equipment. A maximum of 6 ft. 6 in. of headroom within the cage is provided. The model shown was designed for use on a Hortonsphere approximately 43 ft. in diameter.

Moved by Pneumatic Hoist

In use, the cage is suspended by a cable from the midpoint at the top of the sphere, and is lowered or raised as desired by a pneumatic hoist. It can be used for work down as far as 6 ft. below the equator of the tank. Below that level Atlantic maintenance personnel employ commercially-available, metal scaffolds with adjustable-height platforms and mounted on wheels for easy portability.

While designed primarily for the curved exterior surfaces of tanks such as spheres, the cage can serve equally well in eliminating the excess scaffolding usually required on horizontal cylindrical tank painting jobs.



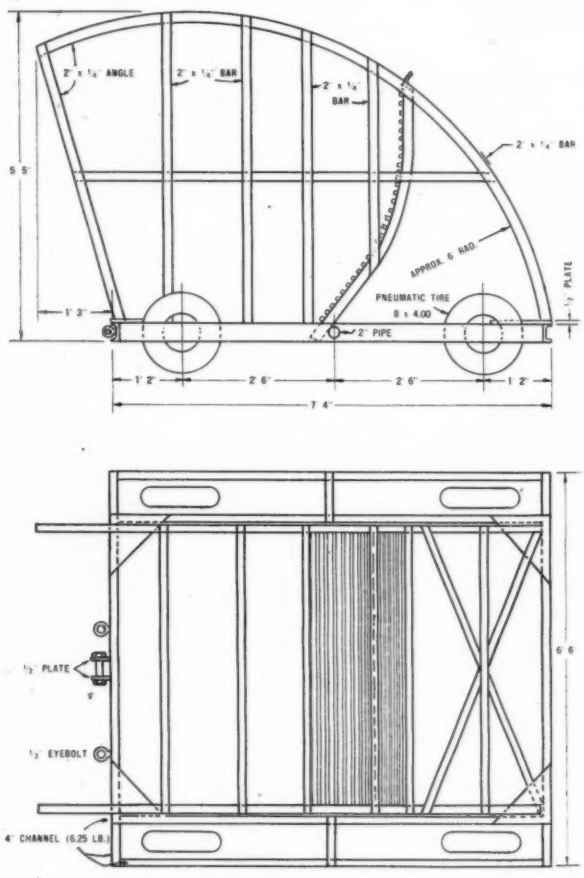


Fig. 1 (right) gives plan and elevation views, with construction details, of the painting and sandblasting "cage" developed by Atlantic Refining Co. for spherical tanks. Photograph at left shows the cage in use

Steam Flange Leaks Stopped Quickly By Injecting Slurry of Gasket Material

OCCASIONALLY gasket leaks may develop in flanges on high pressure (600 psi.) steam lines, or the packing on bleeder valves may fail. It may be inconvenient or even impossible to shut down the line immediately, but it is necessary to stop the leakage to prevent waste and to prevent cutting of the flanges by the flow of high velocity steam.

A technique developed at Sinclair Refining Co.'s Marcus Hook refinery has been successful in stopping such leaks. A suitable plastic material is injected into the flange by means of an orifice connection, if available. If no connection is at hand, a steel strip is laid around the circumference of the flanges and is welded to both as tightly as possible. The steam leakage of course prevents the welder from making a tight seal all the way around.

A nipple is then welded into a hole in the steel strip at some convenient point. To the nipple is connected the discharge side of a small hydraulic test pump. The suction of the pump is connected to a small reservoir made from a 6 x 1 in. reducing swage nipple. Into this reservoir is poured a plastic material made by slurrying ground "Usidurium" gasket material with toluene.

A wood plug or an air line connection serves to apply pressure to the slurry in the reservoir; at the same time the test pump is operated. As the slurry flows into the flange and on out through the leaks, the steam removes the solvent at once, and the residue solidifies, sealing the leak.

The gasket slurry is prepared as follows: Usidurium gasket, 1/32 in. thick, is cut into strips about ½ in. wide with a pair of shears. The long narrow strips are fed through an ordinary domestic meat grinder. The finely chopped gasket material is then mixed in a mortar and pestle with toluene.

On the few occasions this method was employed to stop leaks, very little time was involved in preparing the slurry and in pumping it into the leaking flange. In each case, Sinclair was able to eliminate the necessity of expensive shutdowns. The leaks were sealed effectively and the unit in question was run for several months until new flanges could be installed during the course of a regular, scheduled shutdown.

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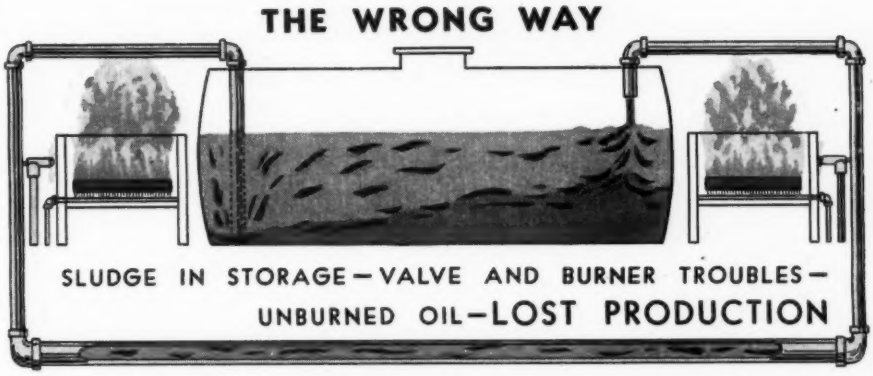

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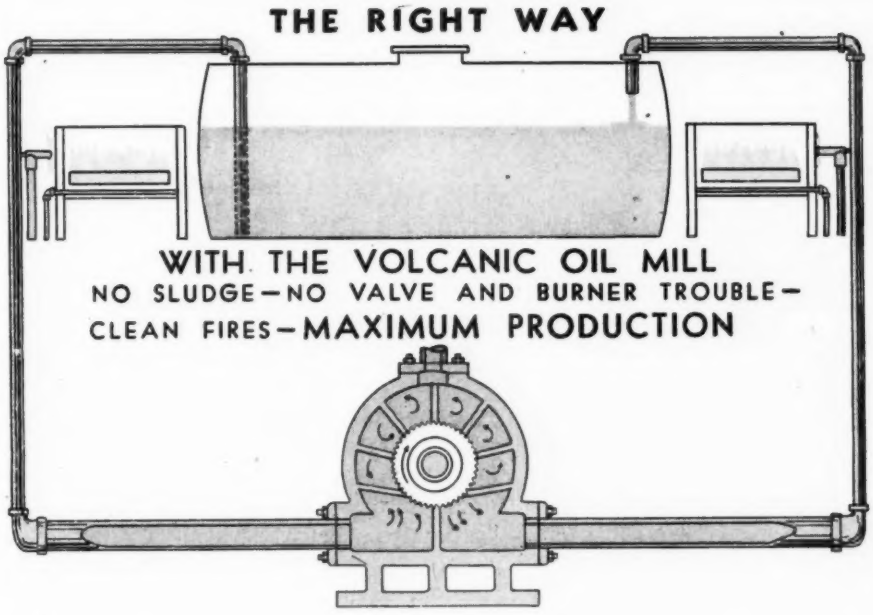
UNBURNED OIL—LOST PRODUCTION

THE RIGHT WAY



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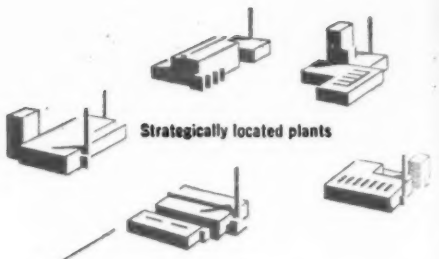

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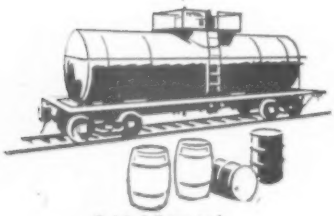

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Laboratory Practices

New Device Combines Grease Working With Flow Measurement in Single Unit

GREASE can be worked and its flow characteristics measured in the same series of operations with a new worker consistometer for lubricating greases developed at the National Bureau of Standards, Washington, by S. A. McKee, chief, lubrication section, and H. S. White, physicist, lubrication section, during investigations of the effect of mechanical working on the physical properties of lubricating greases.

Data obtained at the Bureau indicate the chief advantages of the apparatus are its flexibility, wide range of shear and consistency measurements, short test cycle, provision for flow data while working under controlled conditions, and utility for small samples. The instrument is illustrated in the photograph in Fig. 1 and the cross section in Fig. 2.

It is composed essentially of two coaxial steel cylinders mounted vertically with a capillary-type shearing element between. Close-fitting pistons force the grease through the shearing element in either direction from one cylinder to the other. When flow measurements are made, dead weights are used on the down-stroke and air pressure on the up-stroke.

Various shearing elements can be used. They are made by drilling holes with a No. 79 drill in circular steel disks ¼-in. thick, giving capillaries ¼-in. long and approximately 0.015 in. in diameter. In order to cover a wide range of consistencies, one element has one hole, a second has 10, and a third has 50 holes. The advantage of these multiples of the same size capillaries is the elimination of different capillary dimensions in the comparison of non-Newtonian greases of different consistencies.

The cylinders have a nominal bore of ½ in. and a length of 3⅞ in., while the pistons of hardened steel are 1⅞ in. long. One end of each cylinder is provided with a flange by which the cylinders are bolted together, with the disk containing the shearing element between the flanges. Diametrical clearance between a piston and its mating cylinder is held to a few ten-thousandths of an inch.

The entire assembly is enclosed in a vertical, 7½-in. steel tube, which in turn is encased in an electric heating coil. Mounted below the supporting flange is a brass air cylinder complete with leather-cup piston and rod. The upper end of the rod connects with the lower piston of the worker. Load is applied to the upper piston through a yoke provided with a pan for weights. Thermocouples mounted on each cylinder and on the shearing element disk measure the temperature, which is controlled by mercury-in-glass thermal regulators.

In operation: the upper cylinder is filled to a depth of 2 in. (about 6.6 cc.) of grease, the apparatus is assembled and placed in position. Weights applied to the yoke drive the upper piston down, forcing the grease through the shearing element. A pointer on the yoke, moving along a steel scale, indicates the grease movement. The time is observed for the middle one in. of the 2 in. of travel.

A three-way valve then admits air under pressure to the cylinder, forcing the pistons and grease upward. At the top of the stroke the air pressure is released and the cycle of operations repeated, using the same or a different load on the yoke. A motor-driven lever can be attached to the yoke and air piston rod for automatic working when not timing the rate of flow.

In calibration tests with the apparatus, the applicability of the Poiseuille equation was demonstrated.

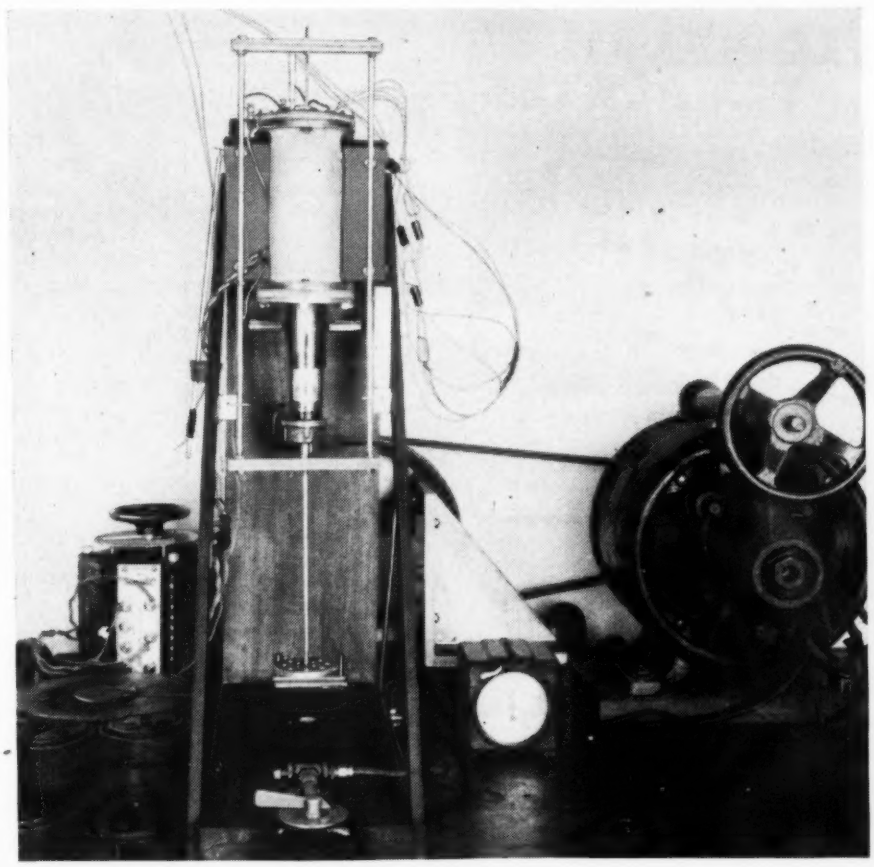

Fig. 1—National Bureau of Standard's newly-developed worker consistometer for measuring flow characteristics of lubricating greases

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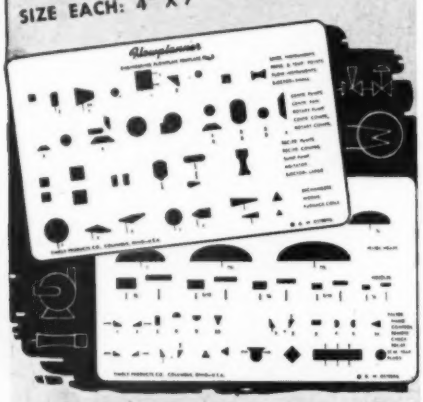

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This is evident from the straight line relationship obtained when n/t, the absolute viscosity of the standard viscosity oil at test temperature divided by the time of flow, is plotted against P, the pressure exerted by the weights moving the upper piston. These data indicate that the effect of temperature, over the range covered (76 to 300° F.), is relatively small and can be neglected.

The resistance to the motion of the pistons is in part caused by the shearing of the oil in the clearance spaces between the pistons and the cylinder walls. This effect was determined by making direct measurements of the rate of motion of the pistons under various loads when the apparatus was filled with oil but without the shearing element inserted between the cylinders. The results were in good agreement with computations of the viscous shear based on measurements of the clearances and the areas under shear. The kinetic-energy correction is appreciable only with the one-hole disk when operating at relatively high rates of flow; that is, when the test cycle is completed in less than 10 secs.

In running a test with the apparatus, flow observations are made successively at each of a number of loads, and the series is repeated until several measurements have been made at each load. The motor-driven lever is then attached and the apparatus operated automatically for a number of passes. The sequence of flow measurements and automatic working are continued for the duration of the test.

Such test data may be shown graphically by plotting the rate of flow obtained at each load against the number of passes. These curves then may be used to obtain flow-pressure curves (rate of flow vs. pressure) for any given pass through the shearing elements. If desired, the values of the intersections of these curves with a horizontal line representing a given rate of flow may be used to compute the effect of working upon the apparent viscosity of the grease at that rate of flow.

The effects of working upon the flow of greases at a given load varied with a number of greases investigated by the Bureau of Standards. With some the flow increased markedly while others decreased. There also was an indication that changes in the rate of working affect the flow characteristics. For example: the flow at a given load of one sodium soap grease increased rather slowly when working was at a comparatively low rate, but the increase was much more rapid at a higher rate. In another case the same held true at the onset of working, and then it reversed itself and the flow *decreased* on further working. Observations made at 100, 200, and 300° F. indicate that temperature also had effects.

The possible rates of shear using the apparatus cover a rather wide range, from about 10 to 100,000 reciprocal secs. During periods of automatic working, the rate of shear has been as high as about 180,000 reciprocal secs.

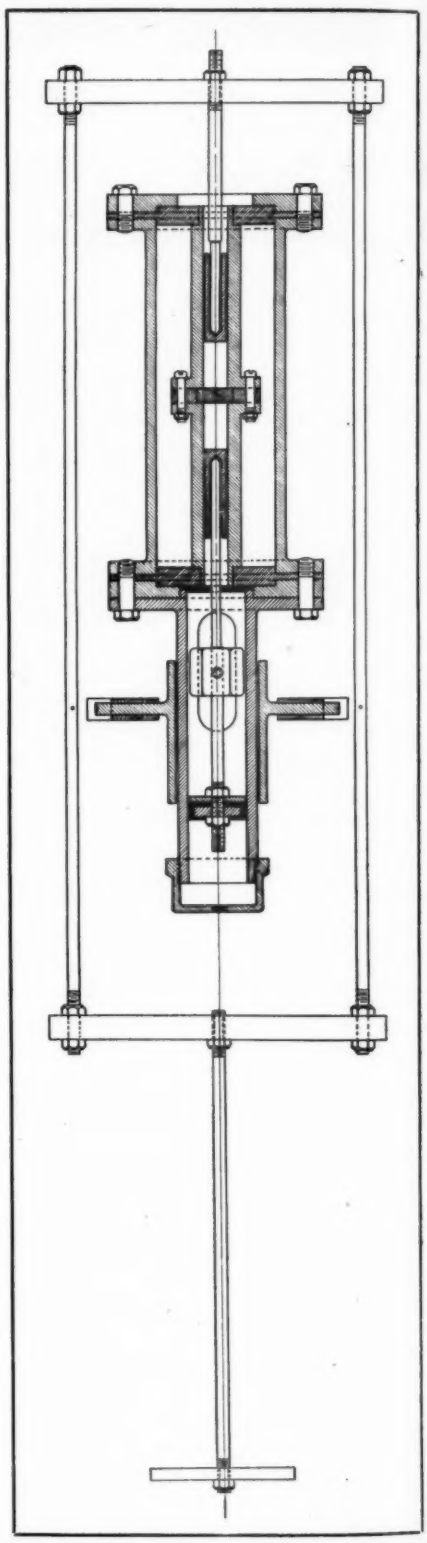

Fig. 2 — Cross section of the NBS grease consistometer

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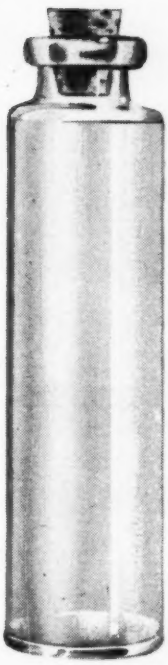

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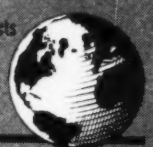

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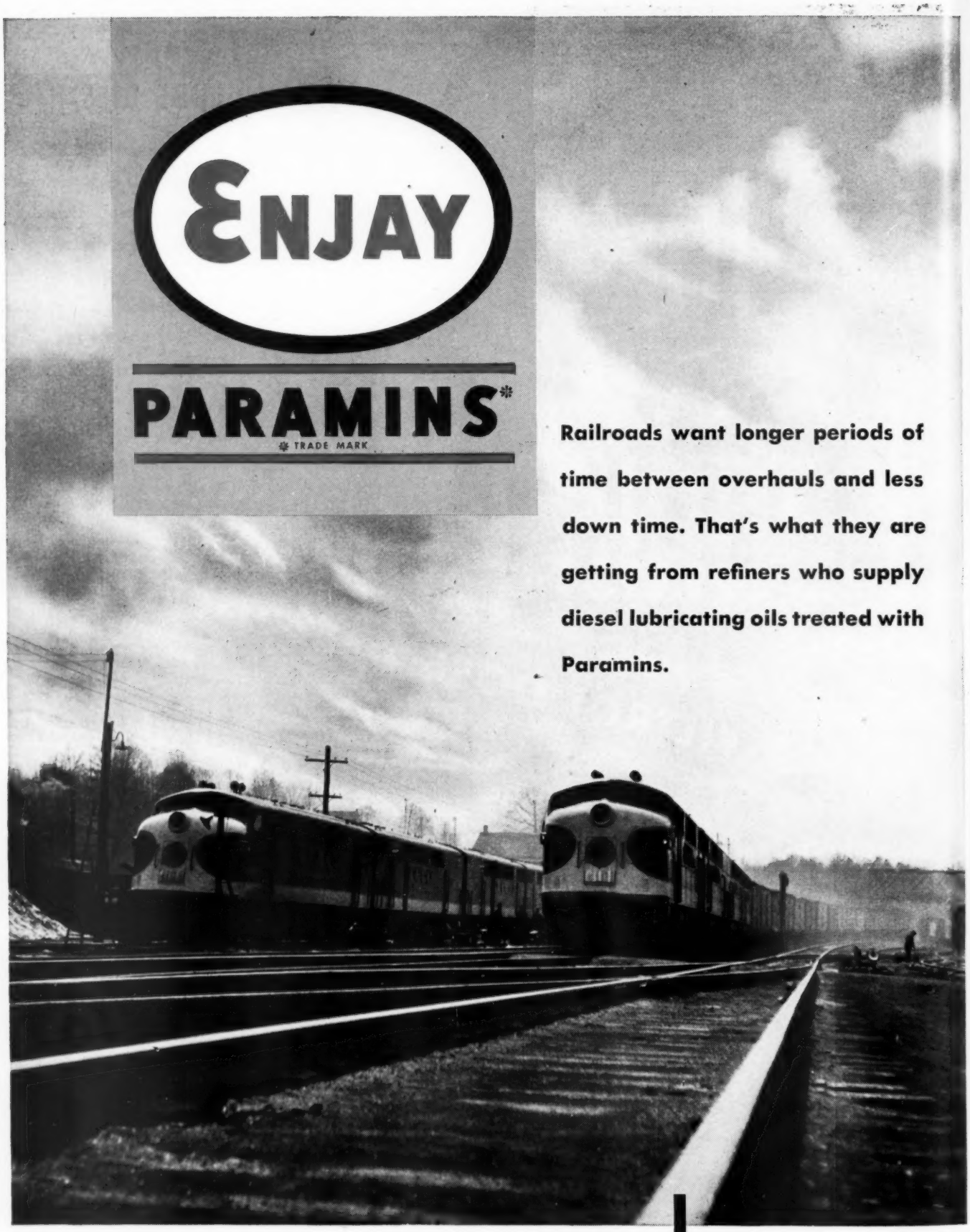
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LEADERS IN PETROLEUM CHEMISTRY—MAKERS OF ADDITIVES: ALCOHOLS: NITRILE AND BUTYL RUBBER: CHEMICALS

Patent Trends in Petroleum Refining

By Peter J. Gaylor, Editor "The Technical Survey"

Recent Developments in Synthetic Lubricants Are Revealed in Review of New Patents

ALTHOUGH petroleum lubricants have been found satisfactory for a large number of uses and have been in wide acceptance in a variety of industries, they are still lacking in some properties which fact renders them unsuitable for a limited but growing number of special uses.

For example, they cannot withstand high temperatures, mainly because, by nature, they are hydrocarbons and thus tend to carbonize and oxidize if air is present. Also, they are flammable and thus constitute a hazard due to burning or spontaneous ignition. For these and other reasons, non-petroleum synthetic lubricants have appeared on the market, and some of them are due to stay unless they are replaced by still more suitable products.

It will be recalled that Carbide and Carbon Corp.'s first U. S. patent on its new synthetic lubricating oils dealt with the condensation of monohydric alcohols with 1-2 propylene oxide.(1) The reaction involved the combining of an alcohol such as methyl or butyl alcohol with propylene oxide to produce an ether-alcohol type of liquid having lubricating properties. Recently, Carbide was granted another patent(2) in which similar products were obtained by reacting dihydric alcohols (such as glycols) with a mixture of ethylene and propylene oxides, and then esterifying the ether-alcohol type product with an organic acid to give fatty acid diesters with lubricating properties.

The latter patent shows that these fatty partial esters also have excellent insect-repelling properties and are also good emulsifying agents for other insect repellents. In this instance, the latter properties are secondary to lubricating properties and our discussion will be limited to lubrication, in which case the diesters have been found quite suitable. They also possess fluidity at low temperatures.

As can be seen from Fig. 1, the diols produced by the condensation possess higher viscosities than their corresponding diesters. Also, the

TABLE 1—Properties of Diols and Corresponding Diesters

	Diol	Diol Di(2 ethyl-hexanate)
Viscosity cs. at 210° F.	5.24	5.22
Viscosity cs. at 130° F.	18.2	14.22
Viscosity cs. at 100° F.	36.5	25.05
Viscosity cs. at 20° F.	870.	318.3
Viscosity cs. at 0° F.	3,544.	1,002.
Density g./cc at 210° F.	.....	0.9087
Density g./cc at 100° F.	.....	0.9536
Density g./cc at 20° C.	.....	0.9670
Refractive index, 20° C.	.....	1.4447
Flash point, 0° F.	.....	432
Fire point, 0° F.	.....	468
Pour point, 0° F.	.....	—70
Miscibility temp. with equal vol. SAE 30 mineral oil	.....	35

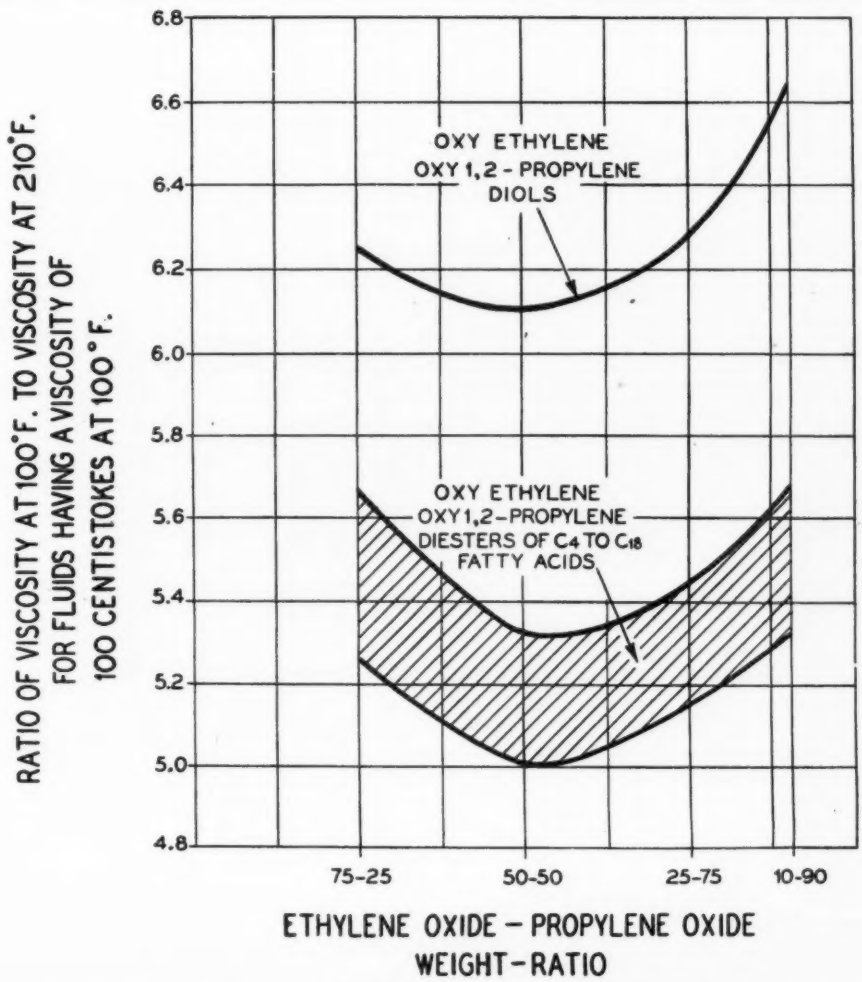

Fig. 1—Viscosity characteristics of oxypropylene diols and their esters

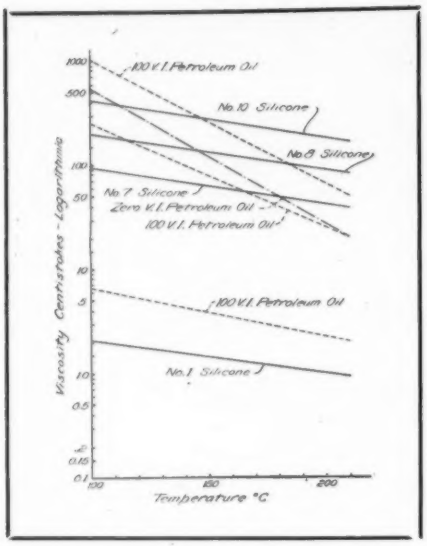

Fig. 2—Comparison of viscosity characteristics of silicones with petroleum oils

ratio of viscosity of 100° F. to viscosity at 210° F. undergoes a minimum in both cases when the ethylene oxide-propylene oxide mixture used in the condensation is in the ratio of 50-50. In one example oxyethylene oxy 1,2 propylene diols having an oxide ratio of 10-90 were esterified with 2-ethyl hexoyl choride, and the product prepared had the properties shown in Table 1, compared with the unesterified diol.

Silicones are also finding extending uses in industry. They are already well known products obtained by heating silicols, whereby polymerization is obtained, giving polymers of any desired viscosity. They are said to meet the seven requirements of a satisfactory lubricant which are: (1) low vapor pressure, (2) high oxidation resistance and freedom from reactivity with moisture, (3) no corrosive action on bearings (which is the difficulty with many petroleum lubricants), (4) flat viscosity curve within the operating range of –30° F. to 185° F., (5) non-creeping over the surfaces lubricated, (6) non-polymerizing or condensing, and (7) nontoxicity.

In Fig. 2 is shown a comparison of the viscosity characteristics of various silicone oils with those of petroleum oils. It will be noted that the viscosity slope of dimethyl silicone polymers is relatively constant from the thinnest liquid to the most viscous liquid, whereas the slope for petroleum oils changes rapidly from the thinner oils to the heavier oils and this change is about three times within the range illustrated.

The aforementioned curves are taken from a patent[3] issued to Westinghouse Electric Corp. which appears to be one of the dominating patents in the field. It covers a lubricant composed of a mixture of liquid polymers of dialkyl silicones in which the alkyl groups each have at least two carbon atoms substantially free of the monoalkyl and trialkyl silicone derivatives. Average molecular weights run above 740 and up to 5000.

Another Westinghouse patent[4] discloses that fluid dialkyl silicones may be combined with colloidally fine solid compounds (such as molybdenum disulfide) to give lubricants capable of withstanding high tempertures and giving excellent anti-friction properties at extreme pressures. As can be seen from Fig. 3, the liquid dimethyl silicone lubricant (A), when tested in a 4-ball machine, shows a relatively high friction coefficient. By adding silica gel, a grease (C) is obtained which shows a slightly lower coefficient. However, the incorporation of 90 gms. of colloidally fine molybdenum sulfide to 50 gms. of lubricant (A) produces a grease (B) which shows a decidedly low friction coefficient that remains practically constant, regardless of the pressure applied.

Merker, of the U. S. Navy, also

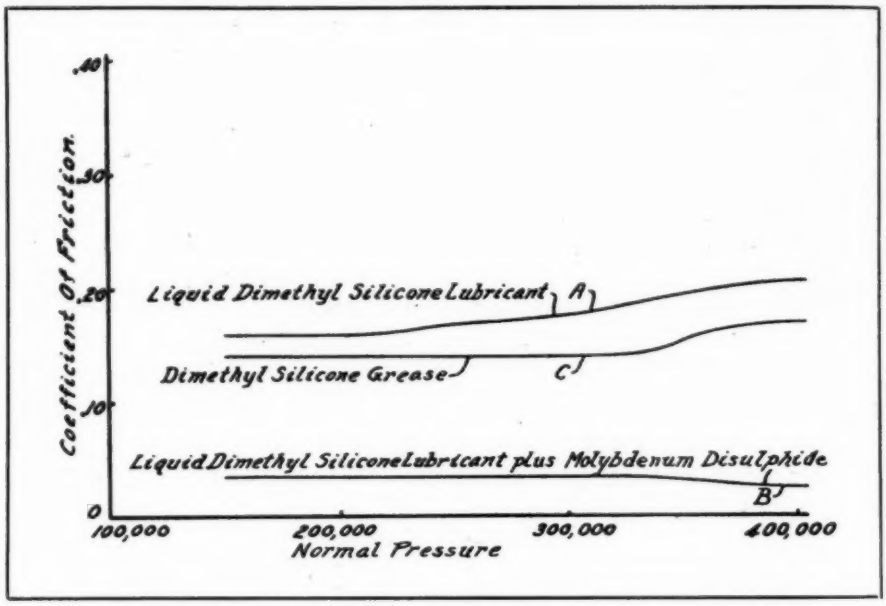

Fig. 3—Effect of solid additives on friction coefficient of silicones

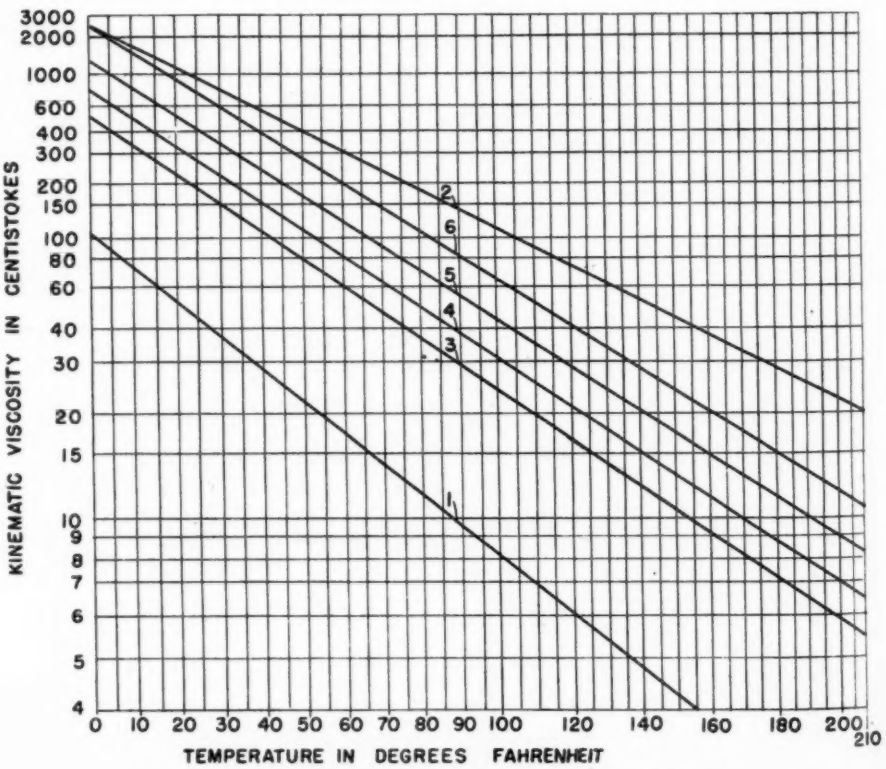

Fig. 4—Viscosity properties of silicone-ester blends

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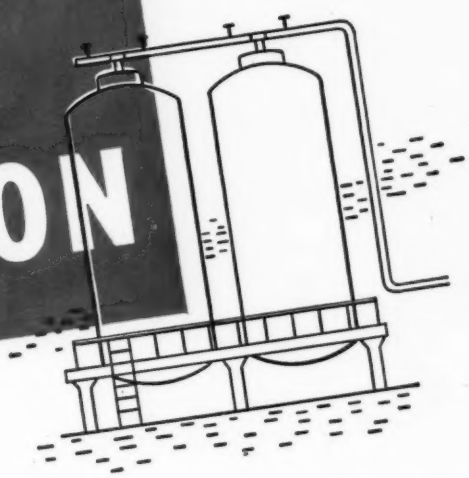

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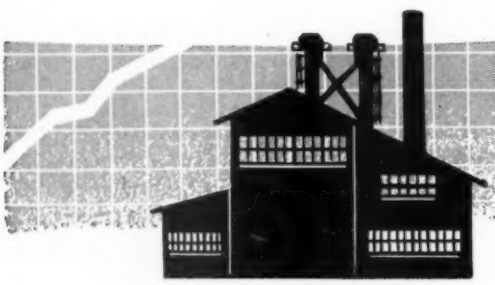

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TABLE 2—Composition of Silicone-Ester Blends

Curve No.	Silicone Parts	Diester Parts	Poly Methyl Methacrylate Parts
2	71.8	20	8
3	69.8	30	..
4	79.8	20	..
5	89.8	10	..

obtained a patent[5] on the production of silicone base greases. He finds that liquid diesters of dicarboxylic or hydroxy acids, when added to the silicone fluids, produce blends which possess substantially all of the desirable properties of silicone fluids and not the undesirable ones (such as incompatibility with soaps, seizing certain metal surfaces, etc.). He also can add polymer thickeners (such as polybutene or polymethyl methacrylate), antioxidants such as 4-tert.-2-phenyl phenol or diphenylamine), rust inhibitors (such as zinc naphthenate, barium mahogany sulfonates, or sorbitan monooleate), and anti-wear additives, such as tricresyl phosphate.

In Fig. 4 are shown the viscosity properties of various blends which have been prepared according to the patent, these being compared with curve 1 for the diester (di-2-ethyl hexyl adipate), and curve 6 of the pure liquid silicone. Table 2 shows the compositions of the other blends represented by curves 2-5, all of which contain 0.2% of oxidation inhibitor. All of these compositions were stored at —40° F. for 10 days without any separation of phases. A grease is obtained by incorporating 5 to 30% by weight of a metal soap thickener to the compositions.

Properties of silicone hydraulic fluids have already been discussed in a previous article[6].

REFERENCES

(1). Petroleum Processing, Nov. 1948, p. 1099.
(2). U. S. Pat. 2,457,139 (Carbide & Carbon).
(3). U. S. Pat. 2,456,496 (Westinghouse Electric).
(4). U. S. Pat. 2,449,510 (Westinghouse Electric).
(5). U. S. Pat. 2,456,642 (Merker).
(6). *National Petroleum News*, June 5, 1946, p. R-474.

Patent Ownership Correction

In the article on the use of tannic acid in regenerating spent caustic, February issue of Petroleum Processing, page 179, ownership of U.S. Patent 2,453,067 was erroneously assigned to Pure Oil Co. This patent, issued to John Happel and Stephen P. Cauley, was and is assigned to Socony-Vacuum Oil Co., Inc., and is a portion of the patent structure behind the Tannin Solutizer Process currently being licensed by Shell Development Co.

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Waste Gas Ignitor Made Safe By Use of Remote Controls

In addition to the safe ignitor for waste gas flares described below; this months' review of new and improved devices used in petroleum processing and handling operations on which patents have been issued recently includes:

- **Electrical strain gages used in float-type level gage**
- **Rotameter float unaffected by liquids containing solids**

SAFETY AND DEPENDABILITY are features claimed for an apparatus for igniting refinery waste gas flares by remote control. The device can be operated without creating dangerous flashes or explosions and is said to be effectively protected from both the heat of the flare and deterioration by weather. It is shown schematically in Fig. 1.

The normal waste gas flare stack 3 is fed from waste gas line 31 through valve 30 at the ignition control point indicated generally by the broken line 33. In case the flare has to be re-ignited, operation is more or less conventional. First, valve 30 is closed. Then valve 32 is opened and the gas jet 12 ignited by closing push-button switch 23 in the circuit to the spark plug 14. Then valve 35 is opened. Flames from jet 12 ignite gases at jet 27, which in turn are used to ignite the main flare at 4 when valve 30 is opened. The other two valves are then closed.

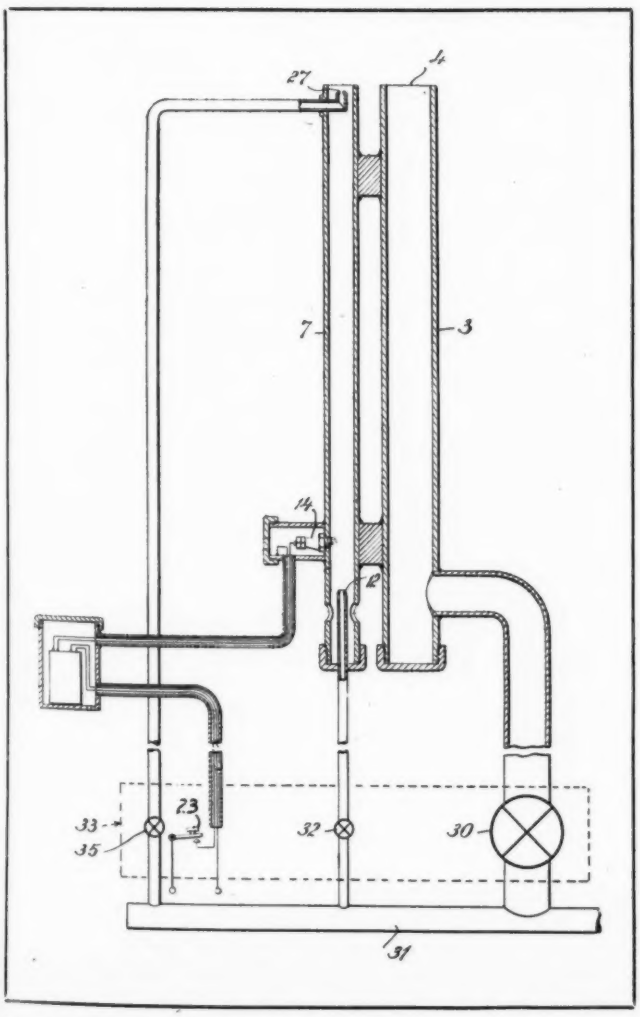
The purpose of using the extra jet 27 is that it acts to induce a flow of relatively cool air through ignition tube 7, thus keeping the lower, operating section relatively cool, and preventing injury to the apparatus from the excessive heat at the main flare 4. The operating control point 33 can of course be located a considerable distance away in complete safety for the operator.

U. S. 2,460,016, issued January 25, 1949, to George F. Kuhn, assignor to Sinclair Refining Co., New York.

Electrical Strain Gages Used In New Float-type Level Gage

ELECTRICAL STRAIN GAGES can be utilized in an improved float type liquid level or specific gravity meter. The strain sensitive elements measure the weight of the float submerged in the liquid. They can be enclosed in a relatively flexible casing, thereby being unaffected by corrosion or by variations in static pressure. In addition, remote recording or control can be obtained.

In general, the instrument is de-



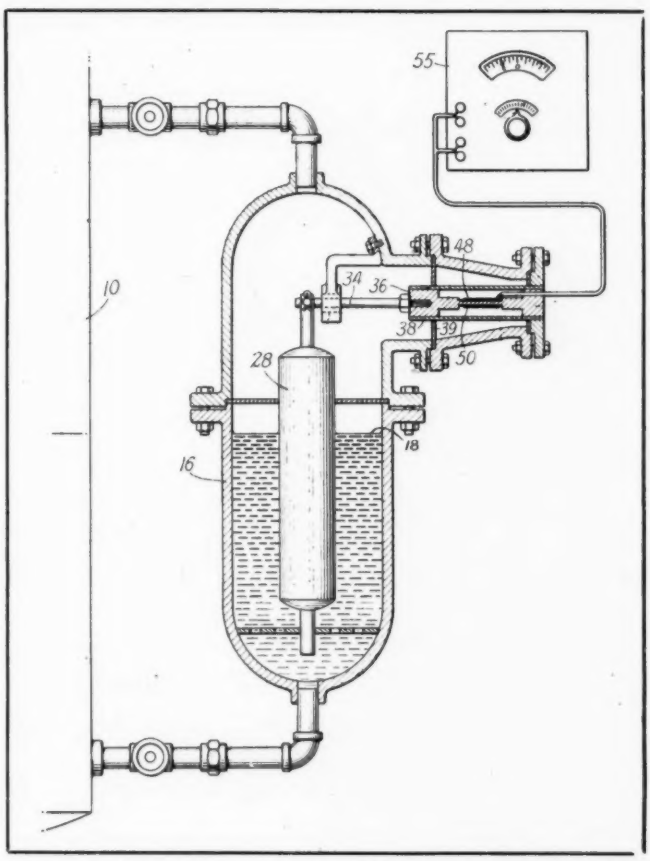
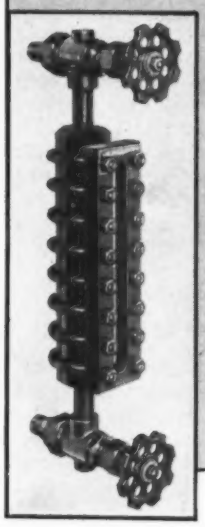


Fig. 1—Left: ignition controls at 33 are safe distance from waste gas flare stack 3 (U. S. 2,460,016)

Fig. 2—Above: strain gage elements 48 and 50 provide improved accuracy in liquid level measurement (U. S. 2,460,503)

When Liquids Boil and Surge the new JERGUSON LARGE CHAMBER GAGE Will Give You A Level Reading



WHEN liquids boil and surge, and use of a coolant is undesirable, the New Jerguson Large Chamber Gage will give you a level reading.

Ordinary gages do not give sufficiently accurate readings on such liquids where the level fluctuates rapidly in the glass. With this new Jerguson, however, the gage chamber is of such large diameter that the level is not badly upset by the boiling action of the fluid. This makes it possible to get close level readings, the kind of readings you want for safety and accurate control.

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signed similar to conventional liquid level gages, as shown in Fig. 2. Float chamber 16, attached to the tank wall 10, is located so that float 28 remains half-submerged in the liquid during normal operating conditions.

In place of the conventional float arm, the device employs a short rod 34 connected to strain gage member 36, which comprises the actual strain sensitive elements 48 and 50 enclosed within flexible cylinder 38 and centered in a diaphragm 39 of the same material. Motion of the float 28 is therefore transmitted accurately by elements 48 and 50 to a Wheatstone bridge type of indicating instrument 55.

U. S. 2,460,503, issued February 1, 1949, to Wilfred H. Howe, assignor to The Foxboro Co., Foxboro, Mass.

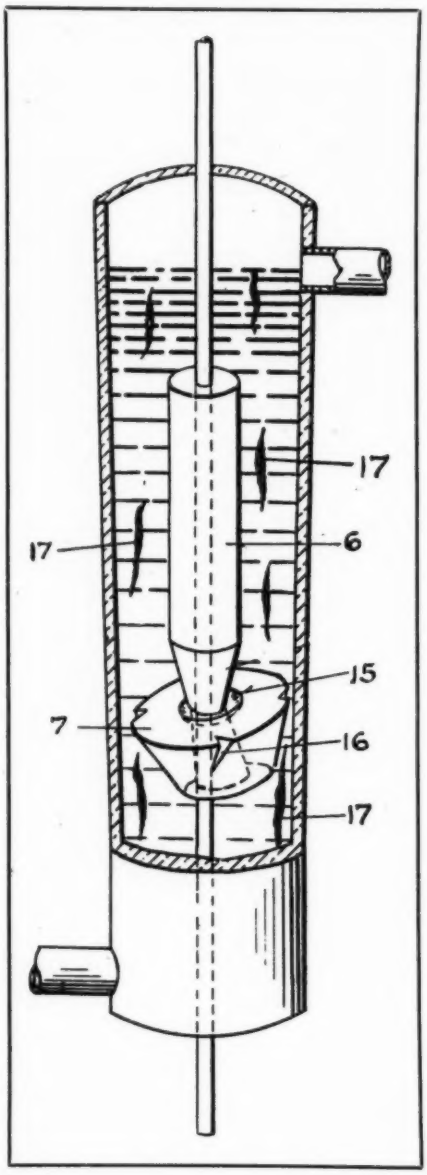

Fig. 3—Solids 17 do not affect the accuracy of the rotameter due to the novel design of tiltable bob 7 (U. S. 2,458,637)

Rotameter Float is Unaffected By Liquids Containing Solids

A DESIGN CHANGE in the float enables an improved rotameter to operate satisfactorily when measuring flow rates of liquids containing solid particles. Normally such liquids tend to foul up the float or bob and block the rotameter tube. The new instrument is illustrated in Fig. 3.

The self-clearing float comprises a weighted section 6, and a lower, rotor section 7, as a separate piece. The diameter of hole 12 in the rotor 7 is tapered outwardly from top to bottom. A dished shape 15 in the top surface of rotor 7 provides a modified ball-and-socket joint between the two sections of the entire float.

In normal operation with clear liquids, the bob 7 remains level. When solid particles 17 hit the underside of the bob 7, it tilts momentarily, allowing such particles to pass on through. The bob continues to spin, however, because of the conventional notches 16, so that the accuracy of the meter is not affected.

U. S. 2,458,637, issued Jan. 11, 1949, to Robert H. Pratt and James Q. Underwood, Jr., assignors to Celanese Corp. of America.

Other Recent Patents

Space does not permit the complete review of all patents issued recently on equipment for the petroleum processing industry. Following, however, are brief abstracts of those with the greatest interest.

Pierced-plate Contacting Tower in which unwanted internal recycling is avoided by redesigning the orifices and the locations of the overflow weirs, resulting in improved interfluid, counter-current contacting. U. S. 2,460,019, issued January 25, 1949, to John D. Long and Cyril O. Rhys, Jr., assignors to Standard Oil Development Co.

Gas or Liquid Is Sampled Automatically from pipe lines at time intervals corresponding to the rate of flow, each sample of predetermined volume; the timing mechanism being connected to a displacement type flow meter and a constant speed electric motor. U. S. 2,461,045, issued February 8, 1949, to George C. Fairbairn, assignor to The Texas Co., Port Arthur, Texas.

Quick-acting Pipe Vise incorporating a snap-action lever for rapidly clamping pipe in place once the vise has been adjusted, and useful particularly for jobs in which a large quantity of the same size pipe is to be handled. U. S. 2,460,079, issued January

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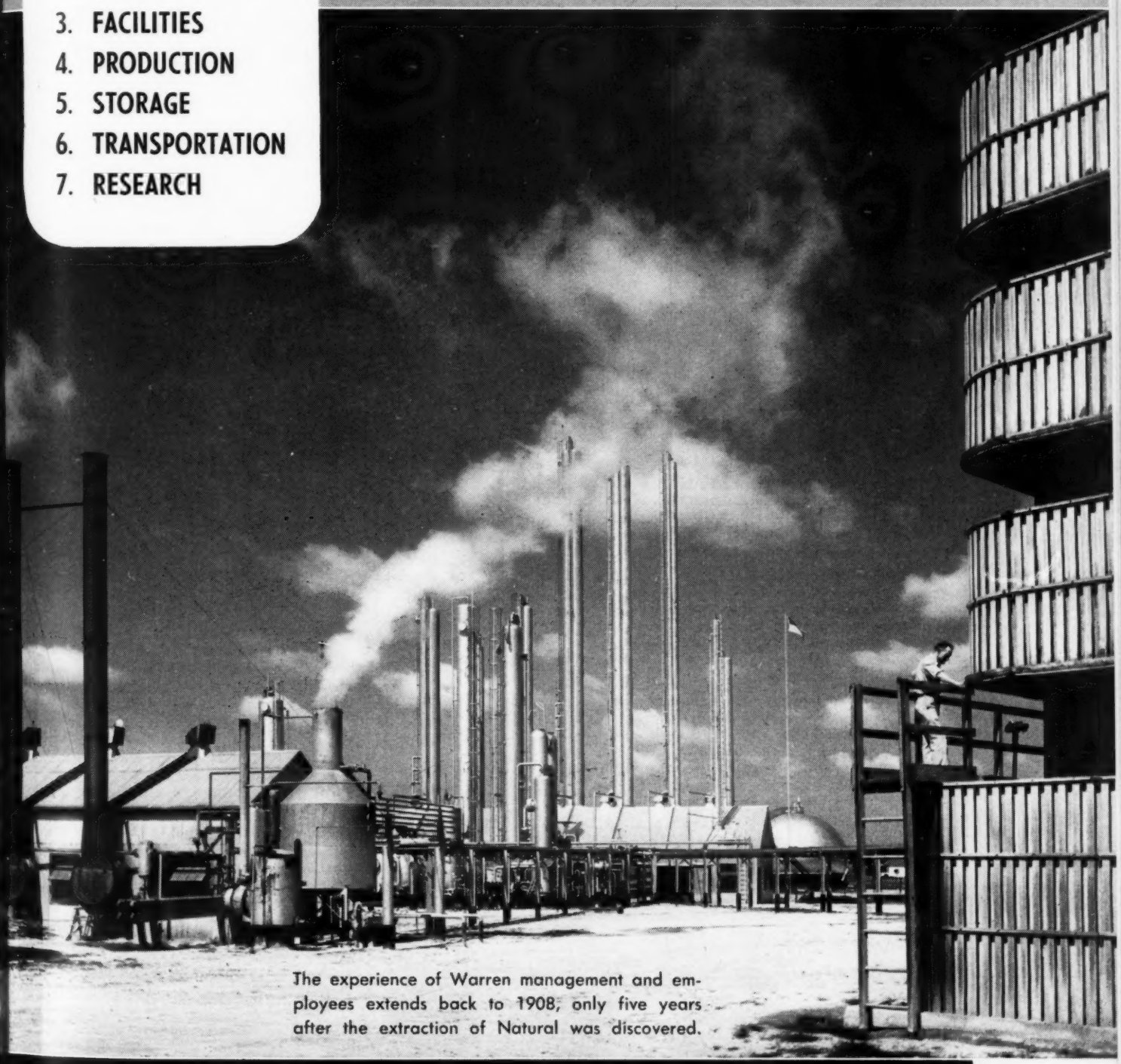

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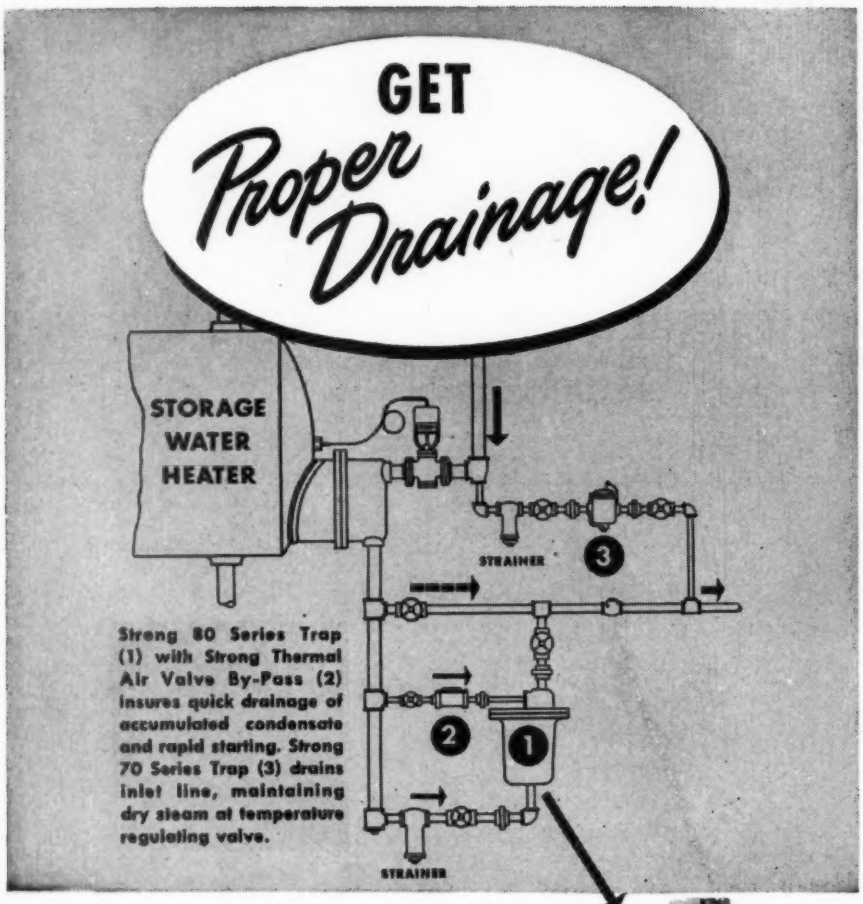
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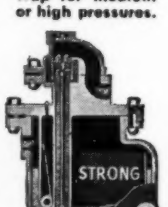

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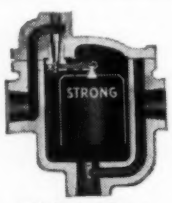


70 Series Trap

Strainer

STRONG

Equipment Patent Review

25, 1949, to Leon J. Ferree, Coffeyville, Kans., assignor of one-half to Melvin J. Huxtable, Kansas City, Mo.

Cone Roof Storage Tank with equipment built in for dehydrating the contained petroleum products, and having drainage troughs on the underside of the roof for collecting condensate so as to prevent further contamination of the tank contents. U. S. 2,460,271, issued February 1, 1949, to Edward P. Baker, New York City.

Catalytic Conversion Unit of the moving bed type, utilizing a conveyor to carry the catalyst upward through the reaction zone and using gravity flow in the regeneration zone; having, in addition, baffle arrangements to provide for transverse flow of both oil vapors and regenerating gases in each of the corresponding chambers. U. S. 2,459,425, issued January 18, 1949, to Charles E. Hemminger, assignor to Standard Oil Development Co.

Catalytic Conversion Unit designed specifically for simultaneous cracking of a relatively heavy hydrocarbon oil, reforming of a lighter hydrocarbon oil, and recirculation of the product stream within one integral unit; comprising an upper reaction zone and a lower regenerating zone. U. S. 2,459,824, issued January 25, 1949, to Frederick W. Leffer, assignor to Universal Oil Products Co., Riverside, Ill.

Combination Centrifuge and Mixer, actuated by a single drive shaft, and found useful particularly in handling both agitation and separation within a single chamber in such processes as alkylation with mineral acids as catalysts. U. S. 2,460,987, issued February 8, 1949, to E. R. Kanhofer, assignor to Universal Oil Products Co., Riverside, Ill.

Screw-type Compressor in which objectionable surges in pressure at the discharge are substantially eliminated by means of a rotary disc valve so that the air or fluid is released only at or adjacent its point of maximum compression. U. S. 2,460,310, issued February 1, 1949, to Gilbert Rathman, assignor to Roots-Connersville Blower Corp., Connersville, Ind.

How to Obtain Patents

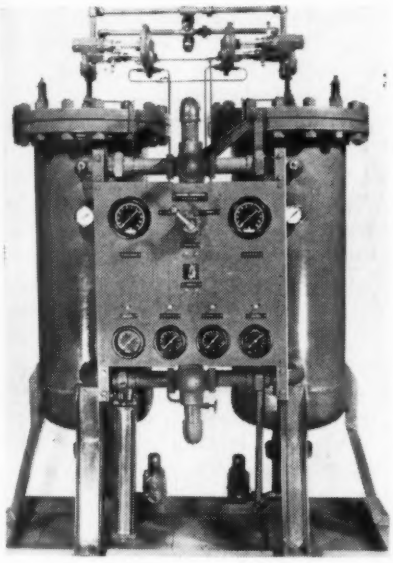
Readers may obtain copies of any U. S. patents from the Patent Office at 25 cents each. Order by patent number direct from: The Commissioner of Patents, Washington 25, D. C.

What's New!

EQUIPMENT . . . MATERIALS . . . PROCESSES . . . LITERATURE

Reviewed by WILLIAM C. UHL, Equipment Editor

1—Instrument Air Dryer



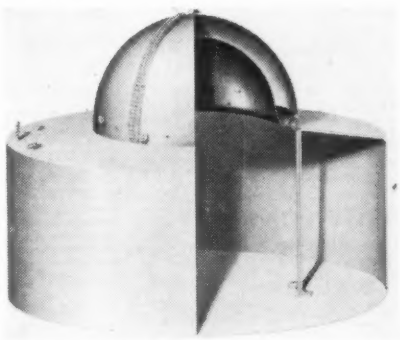
The Industrol Dynamic Dehumidifier incorporates the principle of dual desiccant towers; one being in service while the other is being regenerated. Type of reactivation can be suited to utilities available. Steam above 100 psig., steam at 50 to 100 psig., or electrical reactivation may be employed. Steam-reactivated units are completely pneumatic and require no electricity. Electrical models can be furnished in explosion-proof construction. Standard sizes range from 50 through 1000 SCFM: other sizes on application. Models are supplied in manual, semi-automatic, and fully-automatic types. Desiccant used in Socony-Vacuum "Sovabead." Industrol Corp.

For More Information

Use one of the attached reply cards to request additional information or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the rest of the card, and drop it in the mail. No postage required.

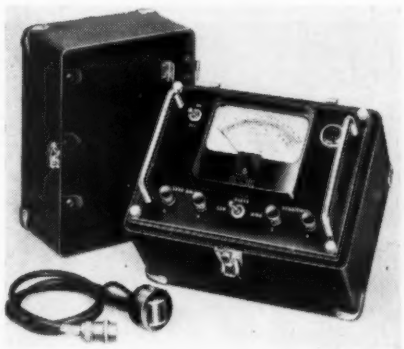
2—Storage Tank Roof

The "Vapordome" Roof is a recent development in vapor saving equipment for flat-bottom oil storage tanks, designed primarily to reduce losses from standing storage evaporation. The outer metal dome contains a flexible dome-shaped membrane which provides variable volume vapor space and allows the air-vapor mixture above the liquid in the tank to expand and contract without being vented to the atmosphere. As the membrane rises, air in the space above the membrane is forced out through an open vent in the top of the metal dome. As the membrane descends, air returns through the same vent. A tank with a Vapordome roof may be operated as an individual unit or it may be connected by vapor lines to the vapor spaces of one or more adjacent tanks. Chicago Bridge & Iron Co.



3—Thickness Gage

The "Coatingage" is a new instrument for measuring the thickness of non-magnetic coatings on iron and steel. Measurements can be made rapidly, without damage to the coating: two concentric scales on the instrument cover a range of 0.0001 to 0.50 in. The instrument's light weight and self-contained battery power supply permit its use in the field as well as in the laboratory or on the production line. Typical applications include measuring the thickness of scale or coke deposits, paint and other protective coatings, metal plating, etc. Thickness is measured by the effect of changes in the reluctance of a magnetic circuit. The instrument is housed in a luggage-type carrying case, 8 in. high, 9 in. wide, and 6 in. deep, weighing 10 lbs. Power is furnished by two 67½ volt batteries and one 1½ volt battery, contained in the instrument. Readings are within 10% of actual thickness. Branson Instruments, Inc.



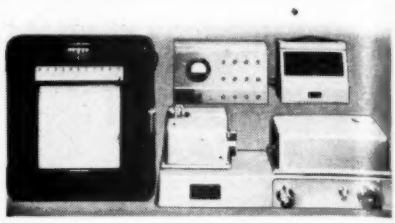
4—LPG Odorant

"Oronite LPG Odorant" has been added to the Oronite line of gas odorants, and is being offered especially for odorizing liquefied petroleum gas as a means for public protection. The compound is an intensely odorous chemical, but of such a nature as not to be objectionable when the gas is burned. It does not form deposits in meters, diaphragms, valves, and other small openings in LPG appliances. Oronite Chemical Co.

More "What's New!" Items, p. 442

5—Six-component Analyzer

Model 12-D "Infrared Analyzer," designed for continuous automatic analysis of as many as six different components in a flowing sample stream, liquid or gas phase, is said to be particularly time saving in the pilot plant for determining optimum process conditions. The instrument consists of the following units: infrared monochromator, similar to that used in the Perkin-Elmer Infrared Spectrometer; turret, automatically driven, 12-point (one reference standardization and one absorption point for each of six components); recorder, Leeds & Northrup, 12-point, strip chart, automatically synchronized with turret; and amplifying circuit, a. c. operation, compensates for changes in ambient temperature, source intensity, etc. The cycling time for a six-component analysis is about six minutes. Operating variables such as temperature, contact time, flow rate, and the like may be changed continuously and evaluated immediately from the automatic analytical record. Perkin-Elmer Corp.



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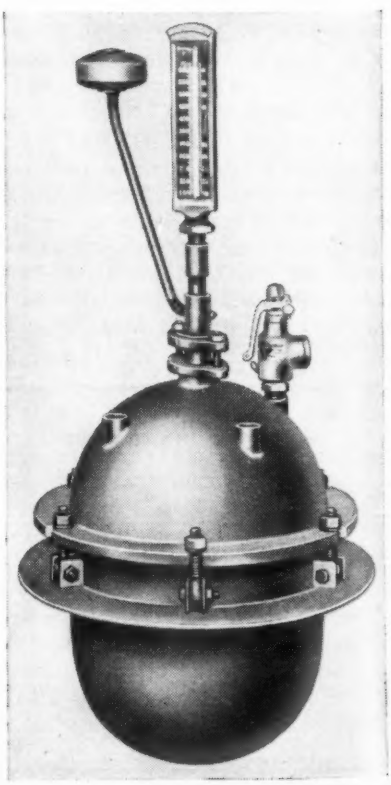
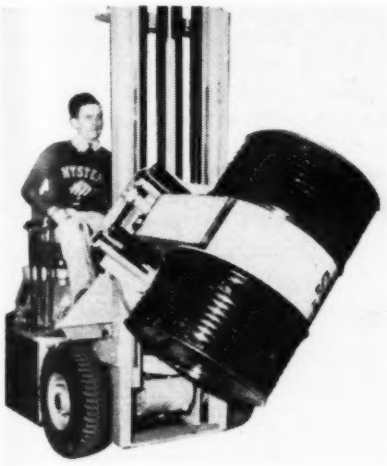
6—Vacuum Pilot Mixer

The Koven vacuum pilot mixer, operated manually, has been designed for testing heavy lubricating oils in test lots of approximately 5 gals. It is made of standard welded steel construction in two sections, using a U-type agitator operated by a hand crank. Removal of the upper shell, complete with agitator and temperature and pressure gages, is accomplished by removal of six swing bolts. Upper and low sections are rubber gasketed for tight vacuum seal. The mixer is designed for either suspension on trunnions over a controlled heat source or for location on a stand or pedestal for handling viscous materials not requiring external heat. It may be had also in stainless steel, stainless steel clad or monel metal for corrosive materials. L. O. Koven & Brother, Inc.



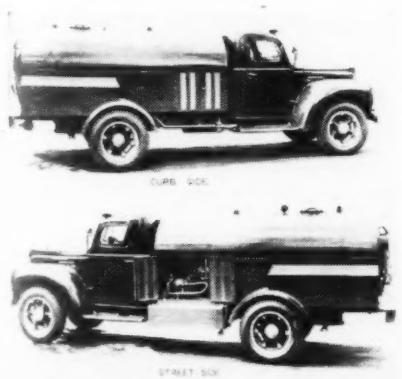
7—Drum-tilting Attachment



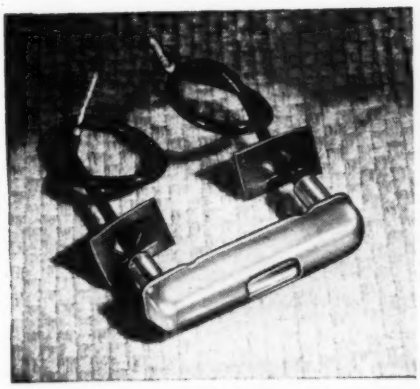
A "Revolving Apron" attachment which makes possible tilting, turning over, or dumping of lift truck loads by a hydraulic mechanism is now available on the Hyster 2000 and 4000-lb. capacity lift trucks. Used along with the "Load-Grab," an attachment which side-squeezes loads with sufficient pressure to lift securely without a pallet, the Revolving Apron can be adapted to special handling operations with such unit packages as drums, barrels, cartons, boxes, crates, bales and the like. Load capacity of the Apron in conjunction with the Load-Grab unit is 1400 lbs. The Hyster Co.

8—Tank Bottom Cleaner

Whittington "Hydro - Scavenger" truck or trailer-mounted vacuum cleaning units, originally designed for the gas industry, are reported to be finding applications in oil refineries for cleaning out sump pits, storage tank bottoms, and various processing vessels. Vacuum is provided by a water jet mechanism which is capable of pulling up to 28 in. vacuum, suitable for handling viscous materials. Unit shown in photograph includes a 500-gal. collection chamber and a steam boiler for heating a drip oil used as a solvent and cleanser. Whittington Pump & Engrg. Corp.

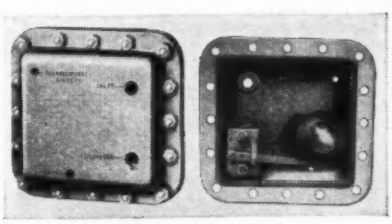


9—Long-life Pilot Lamp



"Tiny-Glow" is a new pilot light for use on instrument panels, switchboards, and the like, which utilizes a small neon lamp, guaranteed for a minimum of 10,000 hours' use, according to the manufacturer. With a current consumption of 1/10 watt, the lamp may be used over a range of voltages from 75 to 250, A. C. or D. C. A Tiny-Glow unit comes ready to install with mounting studs and Speed Nuts, and 4-in. tinned leads. Mounting studs are stocked in standard ⅜ and 3/16-in. lengths. Industrial Devices, Inc.

10—Continuous Drain Trap



Steam, gas, or air condensate mixture enters the new Rockwell Continuous Drain Trap above the condensate, not below or through it. As a result, the trap will eliminate alternate "fill and spill", steam and heat losses, pressure drops, freeze-ups, and other usual difficulties encountered in intermittent discharge traps, the manufacturer states. A slide valve and float mechanism regulates condensate flow according to the volume of condensate accumulation. Condensate or foreign matter is removed by moving the drainage lever on the cover. Movement of the slide valve vertically over the orifice with the rising or lowering of the float helps prevent vapor short-circuiting. Air is released by a hand-operated valve: thermostatic air release up to 100 psi. may be furnished. The trap is made in screwed or flange types for ½, ¾, and 1-in. pipe sizes, for pressures of 150 to 300 psi., and temperatures to 750° F. W. S. Rockwell Co.

11—Fluorine Hydrocarbon

Limited pilot plant production has been announced on a new fluorine containing hydrocarbon, 2-chloro-5-nitrobenzotrifluoride, which is expected to be useful in the preparation of dyestuffs and intermediates. The compound is a straw-colored, thin, oily liquid with a specific gravity of 1.5520 at 20° C. Its freezing point is 16.8° C., boiling point is 230° C., and flash point, 135° C. Hooker Electro Chemical Co.

12—Light Duty Steam Trap

The Super-Silvertop No. 118 is a new inverted bucket type steam trap, developed to fill the need for a small trap at lower first cost for small drainage, light condensate load jobs. It may be installed either as an elbow or straight-in-line without extra fittings. The unit is satisfactory for pressures up to 150 psi. and has a capacity rating of 700 lbs./hr. (continuous flow) at 20 psi. It is made in ½-in. pipe size connection. V. D. Anderson Co.

More "What's New!" Items, p. 444

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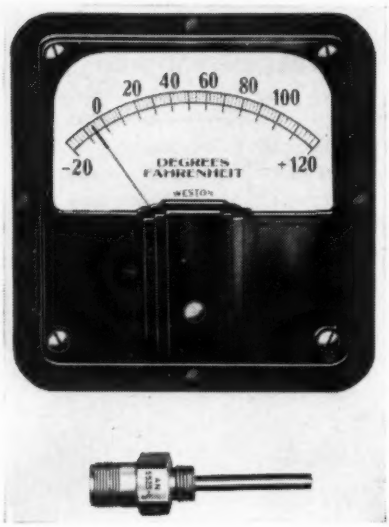
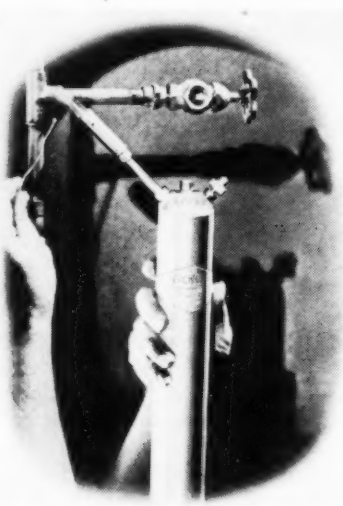
13—Remote Thermometer



Remote indications of temperature at almost any reasonable distance are obtained in the Weston Model 918 electrical thermometer, which employs a resistor bulb as the sensing element. With the incorporation of a selector switch and multiple bulb circuits, a number of measurements are possible with one indicating instrument. The Model 918 is designed for use on 100-130 volts, 50-60 cycles, A. C., and is not affected by normal line voltage variation. It can be supplied also for use on D. C. Weston Electrical Instrument Corp.

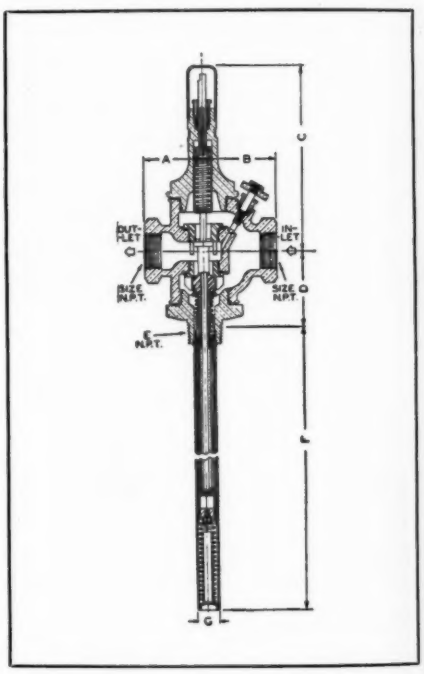
14—LPG Hand Torch

The "Torchmaster" is a general utility, self-contained, hand torch using liquefied petroleum gas as fuel. It has a filtered, "Wind-Pruf" tip which produces a variable sootless flame suited for light brazing and soldering. Measuring 2¼ x 13 in., it will hold enough fuel for an average day's burning operations, and can be used upside down or at any angle. A single control valve turns the torch on or off and adjusts the flame from a pencil point to a full blow torch. Manufacturer states it can be filled from standard LPG containers for from three to five cents. Industrial Engineered Products Co.



15—Cooling Water Controller

The Sarco Cooling Control, No. TR-54-R, provides a new design of self-operated, rigid stem type, temperature regulator for limiting the flow of cooling water through engine and compressor jackets, vapor degreasers, condensers, and the like to maintain a constant temperature. It is the type where the warm water flows over the bulb which is rigidly attached



to a valve in the cold water supply, piped to the bulb location. Closely balanced, double seated valves are said to provide accurate control without danger of sticking or chattering. A separable socket allows the regulator to be removed for inspection without interrupting operation. The unit is available in sizes ⅜ to 1½ in., for water pressures to 150 psi. The regulator is operated by the difference in compression strength of two springs and the thermal expansion and contraction within a tube of oil containing a collapsible tube or bellows. Sarco Co., Inc.

More "What's New!" Items, p. 446

WHEN WE SAY WeldELLS *have everything!* WE MEAN:

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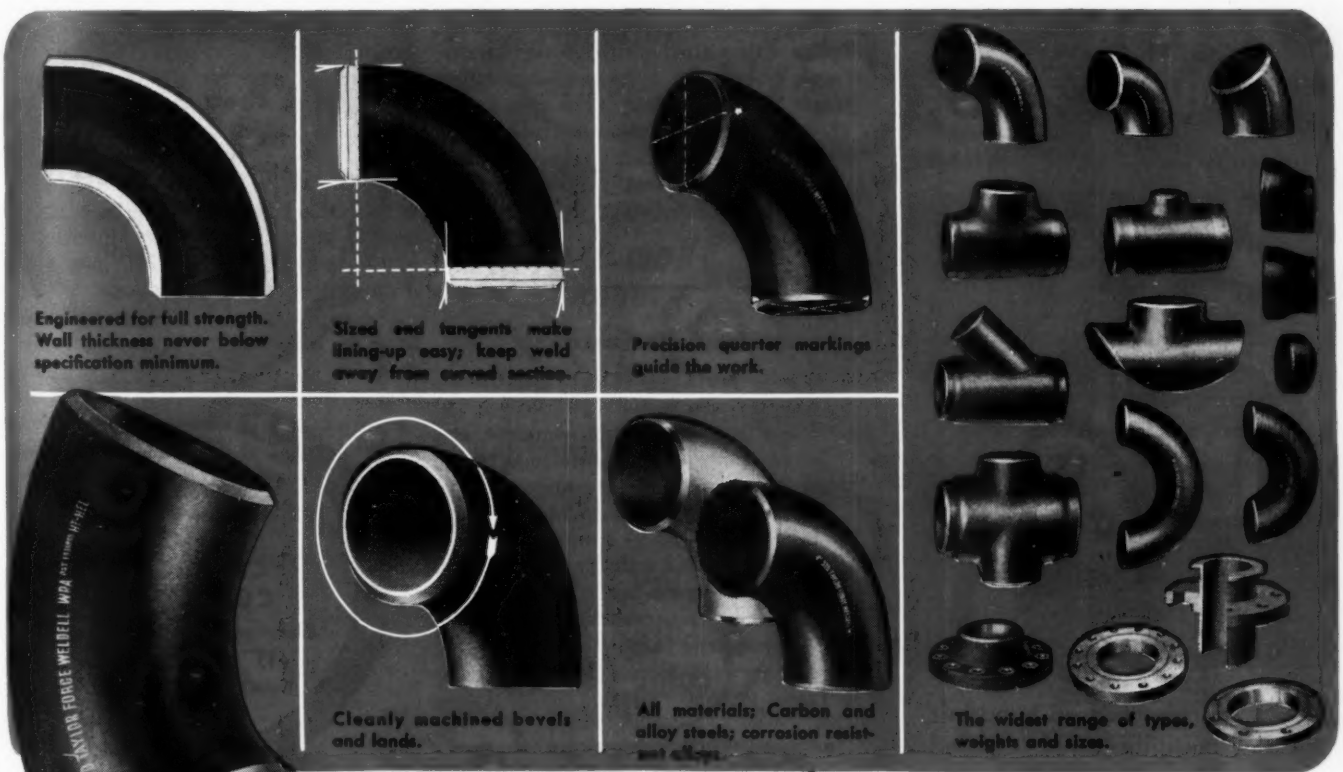
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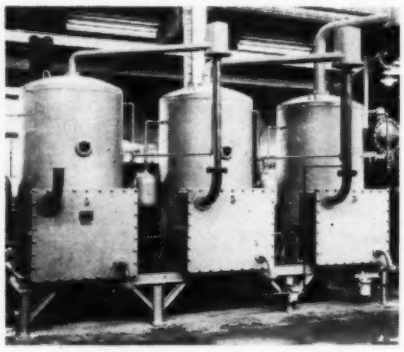
What's New!

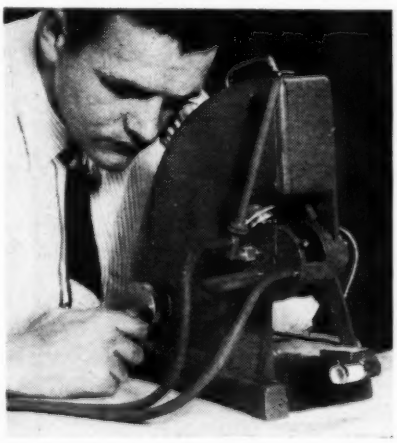
16—Economic Water Stills



Designed to produce high purity distilled water by utilizing low pressure exhaust steam as the heating medium, the new Stokes Multiple Effect Vacuum Water Still is now being made available for general industrial service. The stills can be operated by steam at low pressures discarded from process vessels, turbines, or steam pipes. Models range in capacity from 150 to 1000 gals./hr. Units are furnished complete with fully automatic controls for maintaining constant level in the distilled water storage tank, and are available in single, double, or triple effect models. Construction can be of stainless steel or monel metal to meet special requirements. F. J. Stokes Machine Co.

17—Portable Refractometer

A new portable, electrically-illuminated refractometer by Bausch & Lomb is said to afford accurate refractive index readings in less time than was possible with previous instruments. It has a detachable prism system which can be removed by the user and replaced quickly with a duplicate set to avoid layoffs, should repairs become necessary. Previous models required factory servicing, involving several weeks delay. Bausch & Lomb Optical Co.



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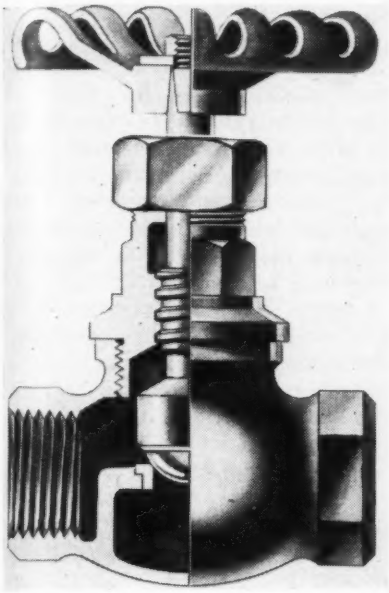
18—Stainless Steel Ball Valve



The "Bull-Dog" Ball Valve employs a precision ground stainless steel ball in place of the conventional discs, poppets, etc., producing a seating member of long service life with harmless effect on the seat, according to the manufacturer. The ball is spun into its retainer allowing a slight clearance, which permits the ball to spin when the valve is opened or closed, thus permitting the ball to find a new seat each time. Ball clearance is held accurately so as to prevent chatter. The valve is supplied with "O" ring seals for normal service where high temperature is not involved. Conventional steam packing is used for steam or other high temperature service. Valves are available at present in ½ and ¾-in. pipe sizes in brass, for 300 psi., water, oil, or gas pressure. Carpenter Mfg. Corp.

19—Fuel Oil Additive

More effective atomization and greater release of Btu's from any grade of fuel oil is claimed by the manufacturer of "Dacarol A," a new activated fuel oil treatment which is said to attack readily both oil sludges and water condensation. Material is applied direct to storage tanks in proportionate dosages per 1000 gals. of fuel oil. It will reduce carbon deposits in preheaters and on burner tips and provide clean lines and tanks. Dacar Chemical Products Co.

More "What's New!" Items, p. 448

Fouts

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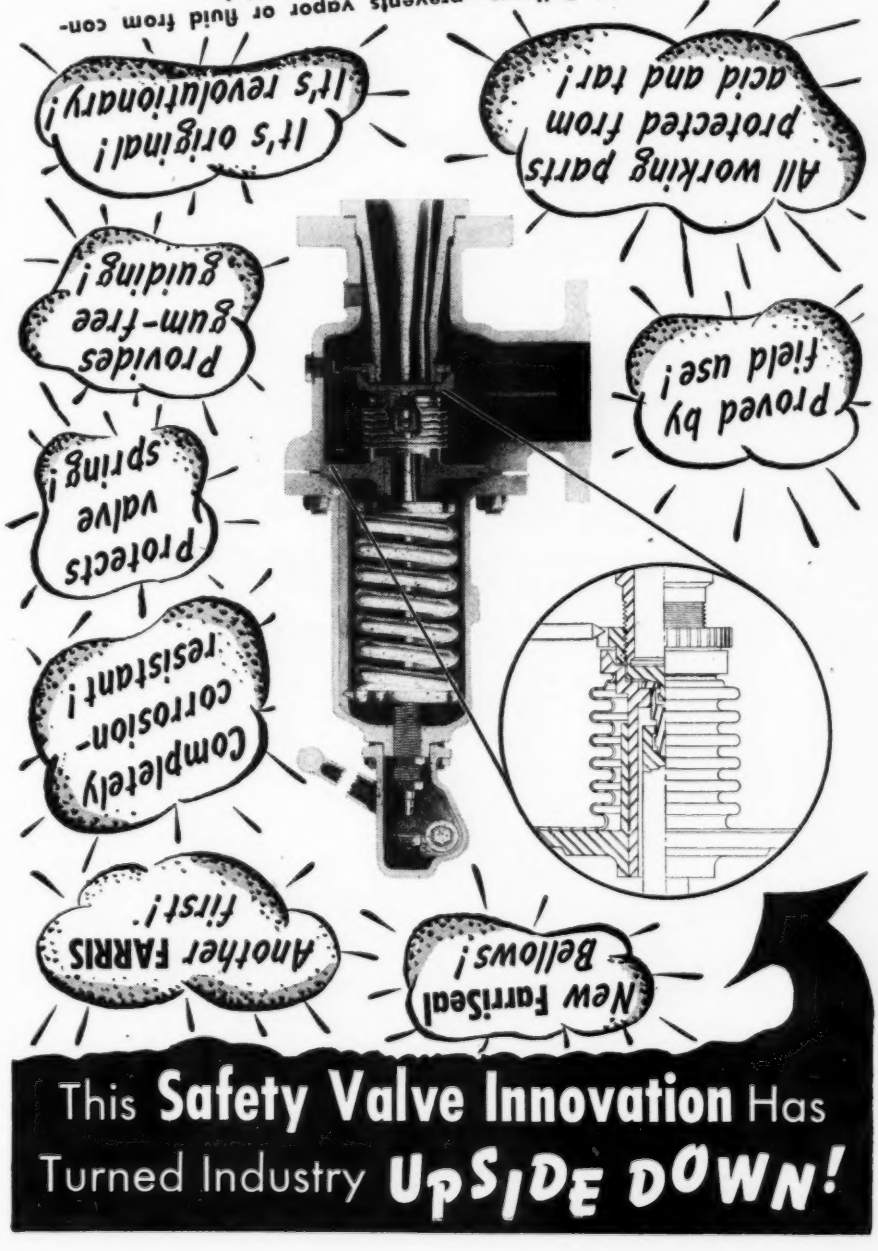

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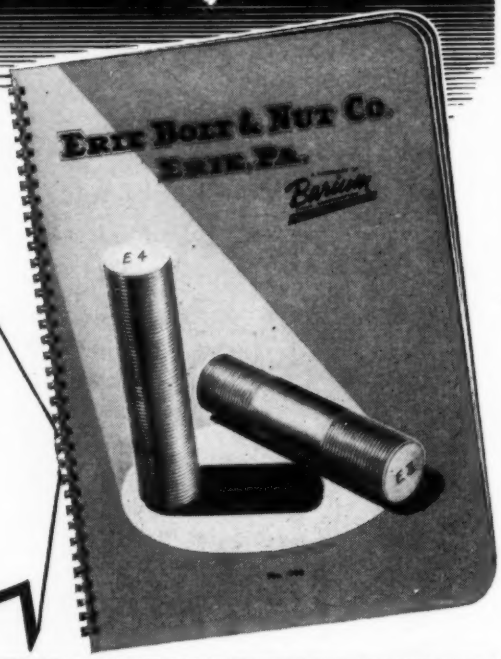

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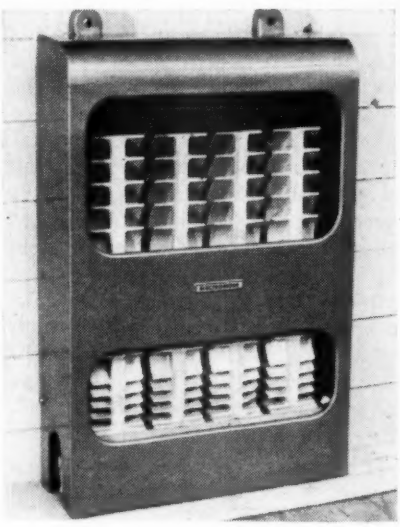
What's New!

20—Safe Electric Heater

The Electromode All-Electric Explosion-proof Heater, said to be the first of its type approved by Underwriters' Laboratories for Class 1, Group D atmospheres, is expected to find wide application in such hazardous locations as pump stations, valve houses, meter houses, bulk plants, and similar locations in the petroleum industry. The patented safety grid heating element consists of a nickel chromium resistor wire, insulated and sheathed in a seamless metal tubing, which is embedded in a one-piece finned aluminum casting. The aluminum grid remains at low operating temperature, but has high thermal conductivity and high resistance to corrosion. Three models are furnished with ratings of 2000, 4000, and 6000 watts. The two smaller sizes can be supplied for operation on 240 and 480 volts, single phase. The largest size is available for use on 240 or 480 volts, single or three phase. Electromode Corp.



21—Fuel Oil Treatment

Nalco SR-155 is a new fuel oil treatment for use in oil-fired boiler furnaces and locomotives. It is designed to prevent formation of sludge in storage tanks, eliminate fouling of preheaters, stop gumming at burner tips, and remove soot in the combustion chamber and flues. The material is added to the oil in the storage and requires no special feeding equipment. National Aluminate Corp.

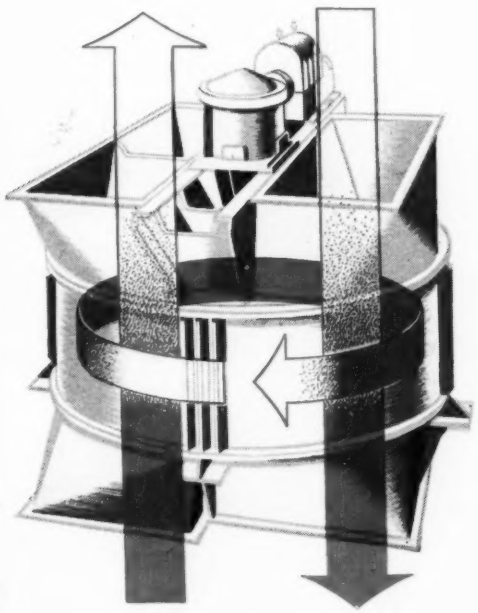
More "What's New!" Items, p. 450

Fact File on Preheat

No. 2

In the Ljungstrom Air Preheater, air and flue gases are each uniformly distributed as they flow through the heating surface. This uniform flow through the rotating heating element maintains nearly constant temperatures at any given cross-section. "Cold spots," which often initiate plugging, do not exist at any part of the heat exchange surface.

LJUNGSTROM



The Ljungstrom Air Preheater is a compact gas-to-air or gas-to-gas heat exchanger, operating on a continuous regenerative counterflow basis. Hundreds of power plants and other special applications confirm its high level of heat recovery and long-term service at low maintenance expense.

THE

AIR PREHEATER CORPORATION

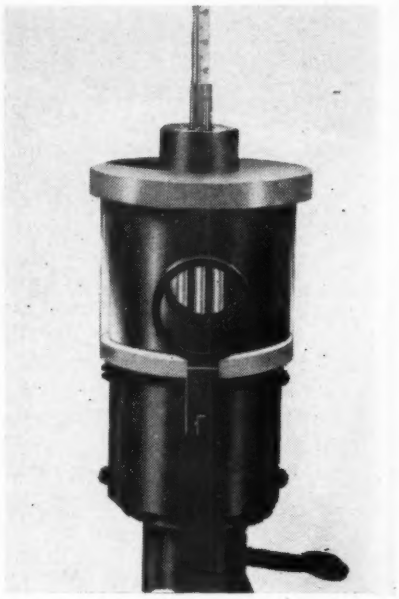
60 EAST 42ND STREET · NEW YORK 17, N. Y.

Plant: Wellsville, N. Y.

960

22—Melting Point Apparatus

Melting point tests up to four times as fast as with other methods is claimed for the new Vanderkamp "Melt-Pointer" (patent applied for). The instrument has a temperature range to over 400° C., and requires no liquids or mechanical stirring units. It comprises three parts: body, chamber block, and adapter. The upper section or block is machined of solid copper; three holes - spaced around the melting point chamber fit over three 110-volt, 50-watt, cartridge type heaters projecting from the base. A thermometer and three capillaries are held in position in the center of the chamber by an adapter plug. A small 110-volt bulb below a window illuminates the interior, eliminating reflected glare from the mercury bulb of the thermometer. A magnifying lens, mounted for adjustable focusing, permits observation of the capillaries. A thumbscrew at the bottom of the assembly permits mounting the unit on any ½-in. diameter support rod. Extra copper blocks are available, permitting the use of one while another cools. Scientific Glass Apparatus Co., Inc.



23—Draftsman's Chair

Complete range of adjustability is claimed for the new Model No. 2422-TR Cramer Drafting Chair. Height of the seat may be adjusted from 23½ to 32½ in. The depth of the seat can be changed by moving the backrest in or out, and the height of the backrest also may be adjusted. In addition, the seat is provided with a forward-tilting mechanism, so that the user can lean forward to work on the upper part of his drawing board. Cramer Posture Chair Co., Inc.

HARDESTY

FIRST FOR FATTY ACIDS

The growing acceptance of the fact that soap is a primary lubricant rather than merely a thickener, adds increased importance to the role fatty acids will play in the manufacture of grease. Hardesty is geared to produce fatty acids in a wide variety of grades and kinds. Write for information on the use of Hardesty Fatty Acids in the manufacture of grease and other lubricants.

HARDESTY FATTY ACIDS

Stearic Acid—Red Oil—Glycerine—White Oleine—Stearine Pitch—Hydrogenated Fatty Acids—Animal and Vegetable Distilled Fatty Acids.

HARDESTY PRODUCTS ARE INDUSTRY'S KEYSTONE

W. C. Hardesty Company

41 EAST 42nd ST., NEW YORK 17

FACTORIES: DOVER, OHIO

LOS ANGELES, CALIF. • TORONTO, CAN.

More "What's New!" Items, p. 452

One Dependable Source of Supply

when you specify

Du Pont Gasoline Additives

You can simplify your refining problems by selecting all your gasoline additives from this complete Du Pont line. These additives have been proved by many years use in the field. They are compatible with each other and are of uniform high quality.

The Du Pont District Laboratory which serves your area is available to assist you in evaluating these additives in your fuel and to make the proper recommendations. Write the nearest district office for additional information on this complete line of gasoline additives.

. . . A complete line to meet every need

Tetraethyl Lead Compounds
. . . Motor Mix . . . Aviation Mix

Du Pont Tetraethyl Lead Compounds are backed by 25 years manufacturing experience. Friendly, cooperative assistance in the solution of problems involving the use of TEL are a part of the comprehensive services DuPont offers in connection with its TEL compounds.

Gasoline Antioxidants
Nos. 5, 6, 22

All gasolines do not have the same likes and dislikes when it comes to antioxidants. That is why Du Pont offers you three gasoline antioxidants, from which you can choose the one best suited to your gasoline.

Metal Deactivator

Copper, an unwelcome catalyst in fuels, is easily and economically controlled with Du Pont Metal Deactivator. In every case, overcoming the catalytic effect of the copper is more economical with Du Pont Metal Deactivator than an attempt at stabilization with antioxidants alone.

Gasoline Dyes
Red, Blue, Yellow, Orange

Du Pont Gasoline Dyes establish the identity of your fuels. Four colors are available and the uniformity of these colors is maintained by careful control. Through mixture of two or more, a wide range of shades can be obtained.

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT PETROLEUM CHEMICALS

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • Wilmington 98, Delaware

DISTRICT OFFICES:
Wilmington, Del.; Chicago, Ill.; Tulsa, Okla.; Houston, Texas; Los Angeles, Calif.

LABORATORIES
Wilmington, Del.; Chicago, Ill.; Tulsa, Okla.; Houston, Texas; El Monte, Calif.

DESIGN YOUR LIQUID STORAGE FOR

MAXIMUM SAFETY and EFFICIENCY

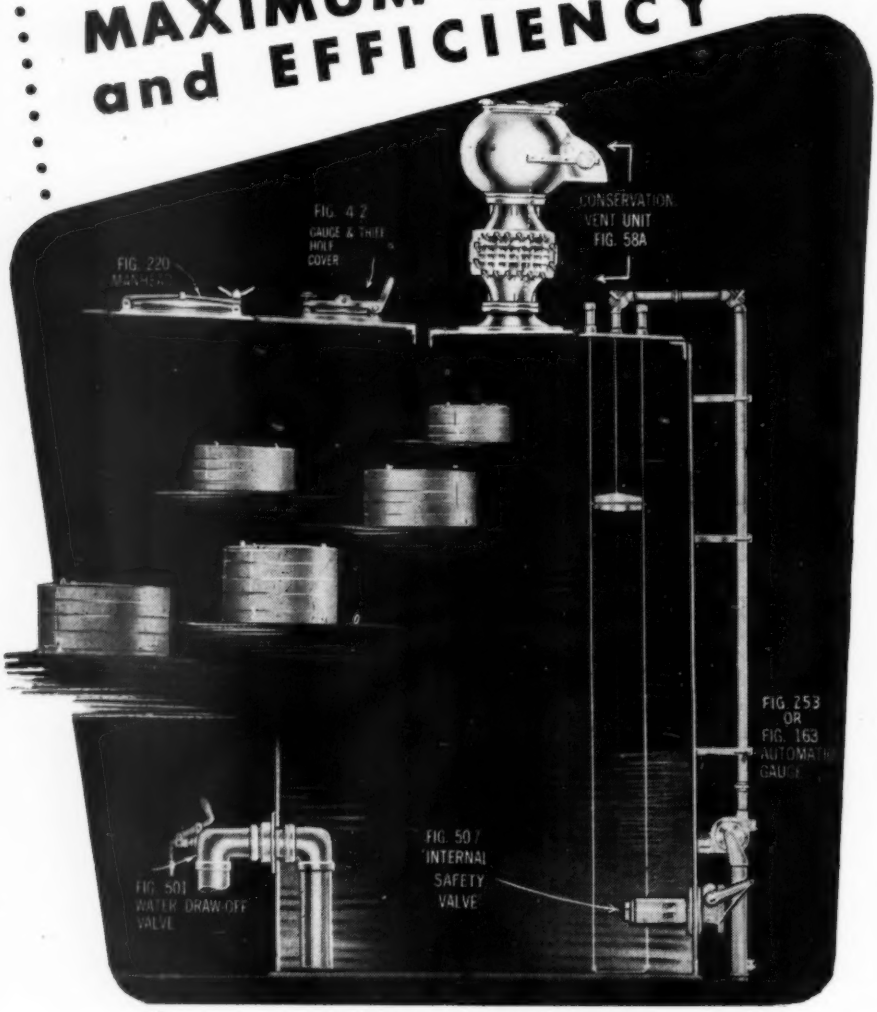


FIG. 42
GAUGE & THIEF HOLE COVER
CONSERVATION VENT UNIT FIG. 58A
FIG. 253 OR FIG. 163 AUTOMATIC GAUGE
FIG. 507 INTERNAL SAFETY VALVE
FIG. 501 WATER DRAW-OFF VALVE

USE "VAREC"
PROVED & APPROVED
TANK EQUIPMENT

Will you be planning additional storage facilities for your liquid products? If so, you'll want your tank builders to meet strict requirements for all your tanks, but you can make doubly sure of safe and efficient storage by including "VAREC" equipment in your plans.

There are "VAREC" Tank Equipment and Safety Devices for all types of tanks . . . and for all types of storage problems. Your file copy of the "VAREC" P-7 Catalog has full details.

CP-8

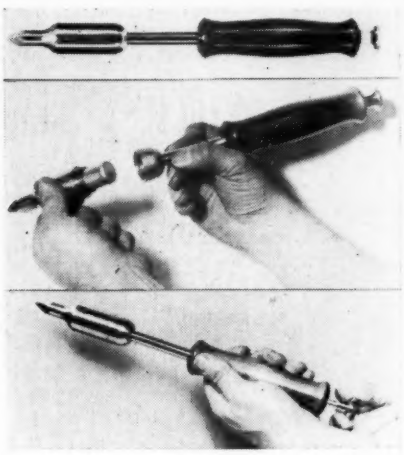
PROVED and APPROVED "Varec"

THE VAPOR RECOVERY SYSTEMS COMPANY
COMPTON, CALIFORNIA, U.S.A.
NEW YORK 30 CHURCH ST. PITTSBURGH 719 GULF BLDG. CHICAGO 122 SO. MICHIGAN AVE.
TULSA 409 TULOMA BLDG. HOUSTON 821A M.&M. BLDG.
CABLE ADDRESS: VAREC COMPTON (ALL CODES)

What's New!

24—Non-electric Soldering Iron

Requiring no electric current or external heat of any kind, the new "Quik-Shot" soldering iron utilizes a chemical cartridge that heats the iron to working temperature in 5 sec. and maintains it at an average soldering temperature of 800° F. for about 7 minutes. The cartridge, about the size of a small flashlight battery, is ignited by the impact of a spring rod which is pulled out and released at the back of the handle. Cartridge consists of magnesium type powders and operates on the so-called "thermit" process, being therefore non-explosive. The heat developed is equivalent to about 250 watts peak. Six interchangeable tip sizes are available, from ⅜ to 1⅛ in. Kemode Mfg. Co., Inc.



Trade Literature

25—Rust Inhibitors

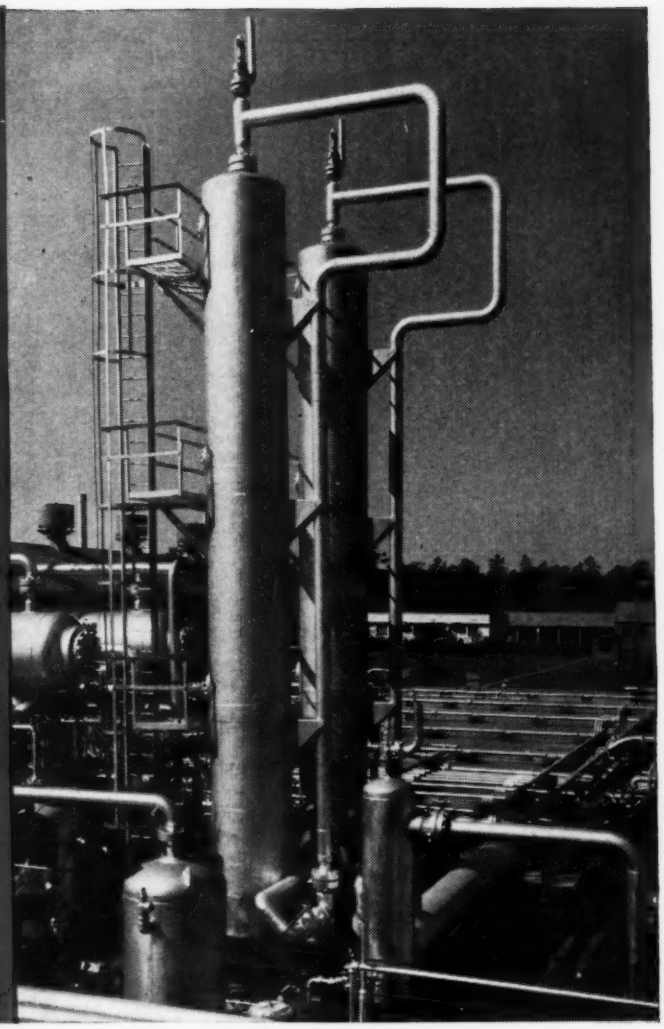
Alox 350, Techhnical Bulletin No. 3; a six-page report on specifications, properties, and results of performance tests on Alox 350, a surface active agent useful in controlling corrosion in internal combustion engines, hydraulic systems, turbine systems, and the handling and storage of fabricated steel parts. Alox Corp.

26—Boiler Feed Pumps

Worthington Centrifugal Pumps for Boiler Feed Service; Bulletin W-318-B7E: 12 pages on specifications, dimensions, applications, and the like for two new, axially and radially balanced, multi-stage, volute pumps, Types UX and UW, two of which are 6-in. size and two 8-in. size. Worthington Pump and Machinery Corp.

More "What's New!" Items, p. 454

The Superior Oil Company Dehydrates with ALCOA ACTIVATED ALUMINA at Lake Creek Field



Dehydrating unit at The Superior Oil Company's Lake Creek Field plant. Each tower is charged with approximately 13,000 lbs. of ALCOA Activated Alumina.

The two 35-foot towers shown in the photograph dehydrate approximately 40 million standard cubic feet of wet gas per day. Each tower is charged with 13,000 lbs. of ALCOA Activated* Alumina. The gas is dried, on 8-hour cycles, to a dew point of *minus* 30° F. The operating pressure is 1550 psig.

The wet gas is dehydrated after it has been passed through horizontal separators, but before it is fed to absorbers.

Throughout the Petroleum Industry, you'll find ALCOA Activated Alumina installations similar to this one, doing a steady, reliable dehydrating job. It is this day-in and day-out reliability that makes ALCOA Activated Alumina an *economical* desiccant. It has high resistance to crushing, shock and abrasion . . . does not soften, swell or disintegrate even when immersed in water.

We should like to tell you more about this highly inert, chemically pure adsorbent. Why not drop a line to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 1780 Gulf Building, Pittsburgh 19, Pennsylvania.

**Registered Trade-Mark, Aluminum Company of America.*

ALCOA

ALCOA CHEMICALS

ALUMINAS AND FLUORIDES

ACTIVATED ALUMINAS • CALCINED ALUMINAS • LOW SODA ALUMINAS • TABULAR ALUMINAS • HYDRATED ALUMINAS

ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE

27—Gas Burner Equipment

"Surface" Standard Industrial Equipment; a composite 130-page catalog and price list on high and low pressure equipment for all common gaseous fuels; including data on furnace design and heat input requirement calculations. Surface Combustion Corp.

28—Temperature Control

Constant Temperature Control, A Manual for the Modern Laboratory and a Catalogue of Requisite Equipment and Accessories; a 64-page booklet, indexed, giving detailed explanation of constant temperature control devices for use in the laboratory. Emil Greiner Co.

29—Vacuum Pumps

Beach-Russ Vacuum Pumps, Type SS, Bulletin No. 87; covers a line of rotary, single stage positive displacement pumps for dry or semi-wet vacuum applications, with capacities ranging from 6 to 375 cfm. Beach-Russ Co.

The direction of plus-
A summary of achievement

Precision engineering research is responsible for uncompromising improvement . . . that every laboratory may have the benefit of even the most recent development.

A glance at the two illustrations above will readily reveal the caliber of engineering advancement responsible for the leadership of Precision-Freas constant temperature equipment. The streamlined mechanical convection oven on the right is a great improvement over its gravity convection predecessor.

As no improvement is ever accepted as final, as no design is ever taken as the last word, persistent engineering advancement and uncompromising improvement is the rule as we endlessly progress in the direction of plus.

Precision Scientific Company
3737 West Cortland Street • Chicago 47, Illinois
BRANCH OFFICES in New York, Philadelphia, San Francisco
DEALERS IN ALL PRINCIPAL CITIES

30—Corrosion Control

Corrosion Control for Underground Pipe, Fiberglas Standards CP3.A1; a 28-page manual dealing with a glass fiber-type of pipe wrapping for protection against underground corrosion, including test data on properties and performance of the wrapping material. Owens-Corning Fiberglas Corp.

31—Boiler Instruments

Bailey Multi-Pointer Gages, Bulletin No. 163-B; 8 pages on dimensions, net and shipping weights, of a diaphragm-operated gage for measuring pressure, draft or differential, and listing standard ranges available. Bailey Meter Co.

32—Pre-Insulated Piping

Underground Steam Distribution, Data Sect. 480-2; and *Typical Engineering Drawings,* Data Sect. 480-3; two booklets, each over 30 pages, dealing with problems involved in layout and design of pre-insulated piping distribution systems. The Ric-Wil Co.

33—New Principle in Flow Meters

Bethlehem Flow Tube, a six-page folder combining cut-away views and engineering drawings to describe the Gentile principle of a new flow-metering device; which requires no straight sections of piping, forms low restrictions to normal flow, and can be used in either direction. Bethlehem Foundry & Machine Co.

34—Lubricant Testing

Required Equipment for Lubrication Control, Bulletin 300, describes a recently announced portable oil inspection kit with which tests for dirt, metal particles, other sediment, and water can be completed in 25 minutes for four oil samples. Gerin Corp.

35—Waste Treatment

Waste Treatment to Comply with Stream Pollution Control Regulations, Bulletin 70, reports case studies and describes briefly general problems and principal water conditioning methods and equipment. Infilco, Inc.

36—Fluid Cracking

The Kelloggram, Issue 5, 1948, comprises an historical review of progress made in fluid catalytic cracking since 1942 when the first such unit went on stream at Esso Standard Oil Co.'s Baton Rouge refinery. M. W. Kellogg Co.

What's New!

37—Process Units & Plants

Process Plants and Equipment, a new 12-page brochure describes "Standard-Plus" line of agitators of all types, absorbers, autoclaves, blenders, condensers, exchangers, mixers, reactors, stills, and valves. Industrial Process Engineers.

38—Silicone Materials

Dow Corning Silicone Note Book, Fluid Series No. 3; a 32-page booklet giving some of the historical background, and including tables and data on properties and applications of the "DC 200" silicone fluids. Dow Corning Corp.

39—Tubular Heaters

BS&B Tubular Heaters; Section 3, Part 5, Catalog 54; 22 pages on a line of tubular heaters, giving types available, data and tables on their application, and specifications. Black, Sivalls & Bryson, Inc.

40—Acid & Chemical Pumps

Lawrence Centrifugal Pumps, Bulletin 203-4; 16-page booklet including diagrammatic drawings, suggested pumping arrangements, and an extensive list of metals and alloys commonly used for pumping various liquids. Lawrence Machine and Pump Corp.

41—Steam Traps

Sarco Thermostatic Steam Traps, Revised bulletin 250-A; an 8-page booklet covering a new line of thermostatic traps fitted with stainless steel elements for corrosive condensates, and for pressures to 300 psi. Sarco Co., Inc.

42—Laboratory Equipment

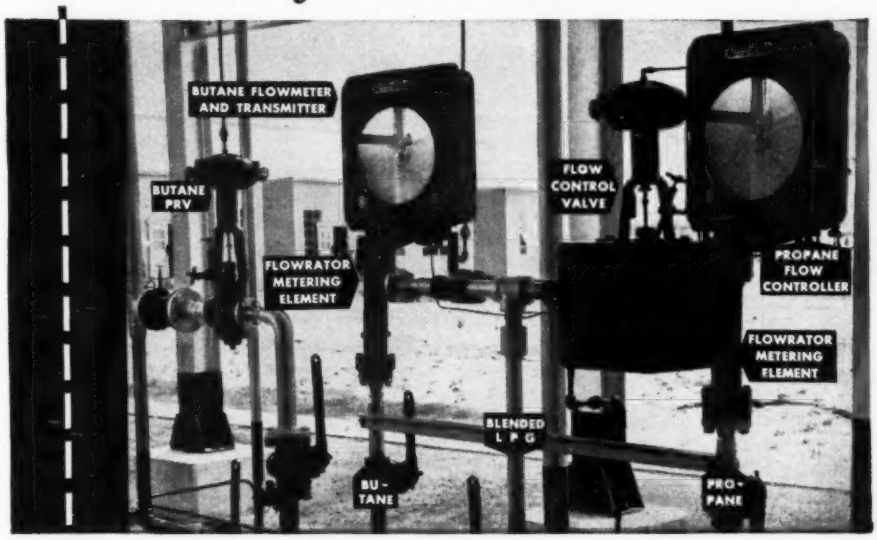
What's New for the Laboratory, Issue No. 7; a 16-page bulletin covering a number of new items of interest to petroleum processing laboratories. Scientific Glass Apparatus, Inc.

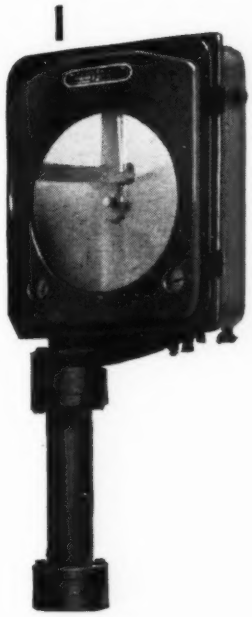
For Your Convenience

Business reply cards are included in this issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing page 440. Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the bottom of the card, and drop it in the mail. No postage required.

LPG BLENDED MORE PROFITABLY AND MORE UNIFORMLY

through simplified straight-line accuracy flow control





The F & P RATIO CONTROLLER blends overhead products from depropanizer and debutanizer columns to exact vapor pressure specifications. It's no longer necessary to change tower operation when vapor pressure specs are altered; you simply turn a knob in the RATIO CONTROLLER to get any blend ratio between 90% C3 - 10% C4 and 10% C3 - 90% C4,

The flow of butane is accurately measured by a FLOWRATOR meter-transmitter. This resets the control point on a similar FLOWRATOR instrument which controls the amount of propane put into the LPG mixture.

Here are a few of the "plus" features of the F & P RATIO CONTROLLER:

1) They record butane and propane flows; valuable operating records are produced without additional flowmeters. 2) Their flow scales are uniformly spaced; peak accuracy is assured over the entire range of flow measurement. 3) They are free of electrical connections; safe in hazardous areas. 4) They require no "meter runs"; installation cost are low. 5) There is just one moving part, free of packing glands; maintenance costs are negligible.

For detailed engineering information write for Bulletin 53.

FISCHER & PORTER CO.
DEPT. 9P-1Z HATBORO, PA.

FLOWRATOR TRADE MARK

INSTRUMENTS FOR FLOW MEASUREMENT AND AUTOMATIC CONTROL

NEWS OF

Manufacturers—Suppliers—Engineering Firms

Serving the Petroleum Processing Industry

Branches, Distributors

Bridgeport Brass Co. has opened a new sales office in the Thompson Bldg., in Tulsa, Okla., with F. S. Snedeker, Jr. in charge. Mr. Snedeker, formerly of the St. Louis office, has had wide experience in the use of condenser and heat exchanger tubing in oil refineries. Tulsa will be served by the St. Louis warehouse.

Tube-Turns, Inc. has appointed the A. B. Judd Supply Co. of Houston, Texas, as a distributor of welding fittings and flanges. A. B. Judd, president of this recently established company, was president of the Republic Supply Co. of Houston until he resigned in 1948 to set up his own organization.

Atlantic Refining Co., Chemical Products Division has appointed L. H. Butcher Co. exclusive West Coast sales representative for packaged chemicals, including the series of alkyl aryl sulfonates—Ultrawets.

Precision Scientific Co. has opened a new branch in San Francisco with Walter A. Blair in charge, at 302 Hobart Bldg., 582 Market St., San Francisco 4.

Vapor Recovery Systems Co. has established a manufacturing affiliate in Paris, France, enabling chemical and petroleum companies operating outside of the dollar zone to purchase VAREC equipment with French francs in France. The company is **Compagnie Technique des Petroles,** with headquarters at 124 Boulevard Haussman. Technical inquiries may be sent direct to the parent company at Compton, Calif., or to the new French affiliate.

Kieley & Mueller, Inc., has appointed the Richard Barthlemess Sales Co., of 105 West Adams, Jacksonville, as exclusive sales representative in the state of Florida. Sales engineers in charge include Richard Barthlemess, H. A. Fleming, Frank Moriarty, and M. C. Thompson.

Swartwout Co., power plant control equipment division, has established a new office at 1817 East Allegheny Ave., Philadelphia 34, Pa. Telephone number is Garfield 6-1055. In charge are R. J. Jones and R. H. Frost, who moved over from engineering, sales, and service activities at the main plant in Cleveland, Ohio. William F. Hawk will continue to represent Swartwout's Ventilator Division from 328 Chestnut St., Philadelphia 6.

Syntron Co. has established a new sales office in Houston, Texas, with W. C. Leasure moving over from the company's general offices in Homer City, Penna., as district sales manager. Nelson C. DeVilling, formerly of Pittsburgh sales office, has been promoted to district sales manager of the new office in Dallas, Texas.

Chain Belt Co. has opened two new district sales offices. A new St. Louis office is located at 8001 Clayton Road, and will be under the direction of Clarence R. Studer, whose earlier experience includes four years with Chain Belt and 19 years with General Electric Co.

A new Jacksonville office, at 340 West Church St., will be under the direction of David B. Hill, with the organization since 1937 as sales engineer in both Chicago and Atlanta district offices.

R-S Products Corp., of Philadelphia, has appointed the Trident Engineering Co., San Francisco, as representatives of the Valve Division.

Hyster Co. has named the McCall-Boykin Co., Inc., as a distributor of Hyster lift trucks, straddle trucks, and mobile cranes in the vicinity of Baltimore. Headed by W. S. Boykin, president, and John M. McCall, vice-president, the company will be located at Calvert and 20th Sts., Baltimore.

Nelson Stud Welding Division, Morton Gregory Corp., has appointed Victor Equipment Co., San Francisco, as exclusive distributors in the Pacific Coast area, effective February 1. Nelson stud welding equipment, available heretofore only through purchase, can now be obtained for a fixed monthly rental fee from any official Nelson distributors and field engineers, it was stated.

Ansul Chemical Co. has expanded its sales network by opening a new district office in Knoxville, Tenn. Joseph F. Ziemann and Troverse F. Schmidt will direct the work of the new office.

Expansion, Transition

Rust Engineering Co., Pittsburgh, has formed a new company, the **Rust Process Design Co.,** to take over the expanding activities of the former Process Engineering Division. Formation of the new company is said to facilitate handling overall contracts in the fields of chemical processing and petroleum refining. The new organization will continue to act as authorized engineer-constructors for units producing ethylene and aromatics by Socony-Vacuum's patented Thermofor Pyrolitic Cracking process.

Named as members of the Executive Committee are Walter L. Bass, Dr. John A. Patterson, Leonard A. Wasselle, and Dr. Wendell W. Waterman.

American Viscose Corp. has anannounce that the Engineering Develcellophane production at its Fredericksburg, Va., plant to 100 million lbs. annually. This is expected to double the present production of Sylvania cellophane and make the plant the largest in the world, it was reported.

Allen B. Du Mont Laboratories Inc. announce that the Engineeing Development and Model Shop facilities of the Instrument Division have been made available to industry for the development, design, and construction of special cathode-ray instruments. Further details may be had by writing the Instrument Division at 1000 Main Ave., Clifton, N. J.

Honeywell Brown Ltd., of Blantyre, Scotland, who are to manufacture the line of instruments made by the parent American firm, Minneapolis-Honeywell Regulator Co., have now been given official authority by the Economic Cooperation Administration to proceed with their building plans. New plant will consolidate previous factories at Perivale and in London, England.

Keystone Driller Co. have announced formation of a new department to enlarge their activity in the industrial and construction machinery field. To be known as the Equipment Division, the department will have offices at 419 Wood St. Services of

The customer knows what he wants . . .

a complete petroleum refinery

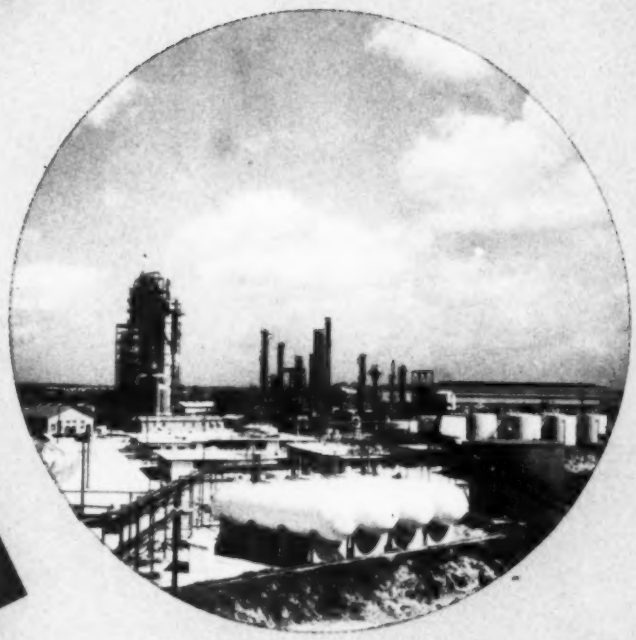
process units—tankage—maintenance shops—loading and unloading facilities—tank car and tank truck loading and barreling—process steam and power—cooling water systems—cooling towers, etc.

design

engineering

fabrication

construction



The customer gets what he wants . . .

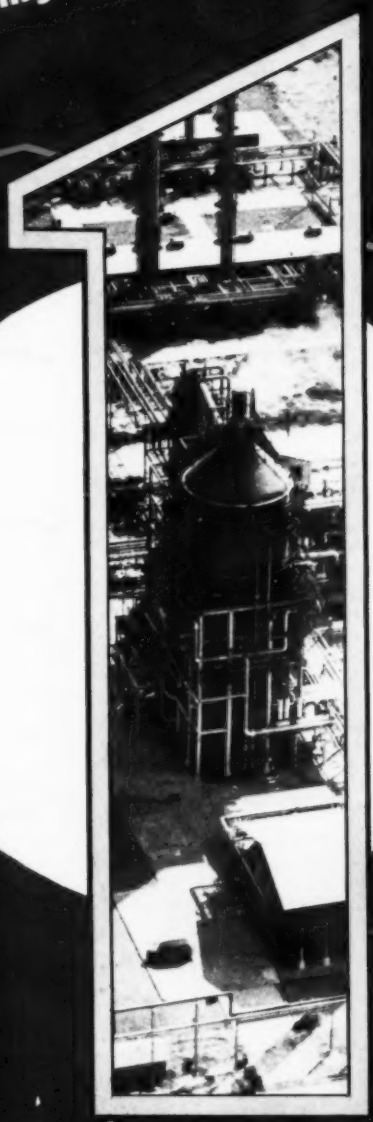
when his experience and knowledge is joined with that of an engineering service which has built over 400 process units . . . complete refineries and chemical plants.

Collaboration pays off—in time and money.

FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK

one . . . complete . . . engineering and construction service



complete petroleum
refineries and
chemical plants

one contract

one contractor

one constructor

FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, NEW YORK

Robert H. Fox and Associates of Van Nuys, Calif., have been acquired to direct the engineering and marketing of this line of equipment, which will include heavy duty material handling cranes, etc. The Keystone factory is located at Beaver Falls, Pa.

Industrial Process Engineers have moved from their previous location in West New York, N. J., to a new and larger plant at 8 Lister Ave., Newark, N. J.

A. O. Smith Corp., Vessel Division, has completed establishment of a complete shop for manufacturing heat transfer equipment in Milwaukee. P. A. Thompson, who comes to A. O. Smith after 18 years with the Alco Products division of American Locomotive Co., has been appointed product supervisor.

Thomas C. Wilson, Inc., has purchased the tube expander business of Richard Dudgeon, Inc. Manufacturing activity will be combined at the Wilson Co. plant in Long Island City, N. Y.

Personnel Changes

Askania Regulator Co.—Wilson W. Wheeler, with the company in the sales engineering department since 1941, has been appointed Sales Manager. Prior to his association with Askania, Mr. Wheeler was a mechanical engineering consultant in Cincinnati.

Kerotest Mfg. Co.—Kenneth F. Vilsack has been appointed Chicago district sales representative. He will engage in the sale of oil field, refinery, chemical processing and general industrial steel valves. He was previously with the company's general sales office in Pittsburgh.

Koppers Co.—G. W. Naylor, formerly general manager of manufacturing for Sun Chemical Corp., has been named manager of the Development Section, of Koppers' Chemical Division. He will make his headquarters in Pittsburgh.

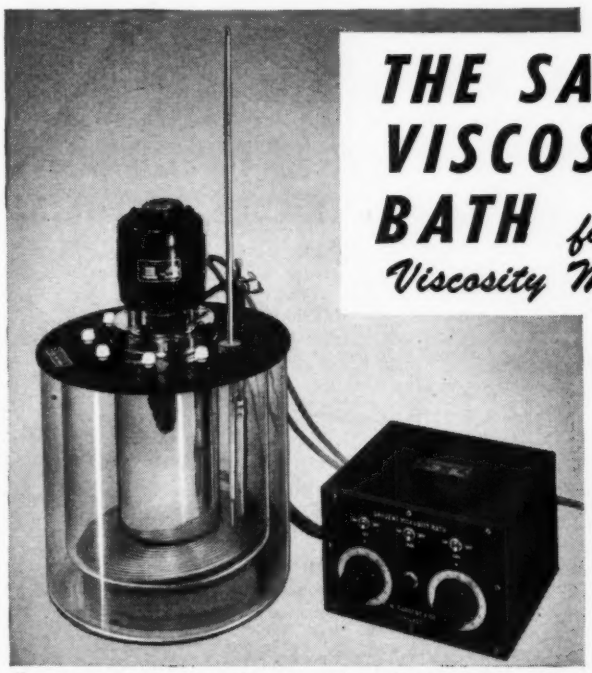
Dowell, Inc.—Herbert A. Koch, formerly general sales engineer in Tulsa, has been named head of the Fort Worth, Tex., office. He will be coordinating sales activities in the Fort Worth-Dallas area.

Pacific Pumps, Inc. celebrated its 25th anniversary recently with an inspection of plants and facilities by officers of the parent organization, Dresser Industries, including Neil H. Mallon, president; John B. O'Connor, executive vice president; William A. McAfee and Prescott S. Bush of the executive committee. Arthur R. Weis, president; and Elmer J. Weis, vice president, Pacific Pumps, conducted the party on its tour.

Girdler Corp.—Harold E. Huber has been appointed head process engineer of the **Votator Division.** A native of Louisville and a graduate of the University of Kentucky, Mr. Huber began his career with Standard Oil Co. (Indiana) in 1938, where he was engaged in exploratory research and pilot plant work until 1943, when he joined Girdler.

Marlow Pumps—Vincent Vandervoort, a New Jersey banker and retired as president of Watson Machine Co. a year and a half ago, has been elected vice president of Marlow.

Kieley & Mueller, Inc.—Robert J. Donnelly, with the firm for the past ten years, has been appointed gen-



THE SARGENT VISCOSIMETER BATH *for Kinematic Viscosity Measurements*

The Sargent viscosimeter bath has been in general use, in its essential form for more than ten years and because of the soundness of its design, the present stock differs only in minor refinements from the original models.

Precision of automatic temperature control in the Sargent bath is actually, at least as good as its rating of ±0.02° F. and in order to attain this degree of efficiency we believe an oil bath must have the following essential factors.

1. **Lagless heaters** formed of heavy gauge chromel helices directly exposed to the oil.
2. **A high rate of circulation** using directed turbine flow.
3. **Variable input** to the permanent and intermittent heaters, such that the steady heat supply can be set to compensate the greater part of the steady rate of heat loss, leaving a minimum wattage to be applied by the intermittent heater, as the cyclic correctional increment.
4. **Double walled container.**
5. **Thermoregulator** of the maximum sensitivity compatible with serviceability characteristics.

The proper balance of these factors makes the Sargent viscosimeter bath the only bath which we are certain is capable of the rated precision when using oil as the bath medium and operating in the vicinity of 210° F.

Specifications:

Range: to 210° F.
Dimensions: Inner jar diameter 10", depth 10"
Outer jar diameter 12", depth 12"
Precision: 0.02° F.
Maximum Power Consumption: 1200 watts.

S-83255 VISCOSIMETER BATH—Oil, Constant Temperature High Precision 0.02° F., Sargent (Patent No. 2,037,995). As described, for use from 115 volt 50/60 cycle A.C. circuits..... **$230.00**

SARGENT

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eral sales manager. Ward K. Stallings, following 11 years in the production, engineering, and sales departments, has been named chief engineer. A. W. Bailey, who joined Kieley & Mueller in 1948 after a number of years with Fisher Governor Co., was appointed general office manager.

Lukens Steel Co.—Edmund Pfeiffer, previously a member of the Coatesville District sales staff, has been made assistant district manager of sales of the Boston, Mass., office. He will assist H. G. Austin, who continues as Boston manager of sales.

Houdry Process Corp. — Brig. Gen. David N. Hauseman, president, has been elected to the board of managers of the Girard Trust Co. of Philadelphia.

Fairbanks, Morse & Co. — O. O. Lewis, until a short time ago assistant sales manager, has been promoted to sales manager, with headquarters at company's main office in Chicago. Harry L. Hilleary, who replaces Mr. Lewis as assistant sales manager, has for past 17 years been manager of the St. Louis branch. L. A. Weom, manager of the Pump Division, has been transferred to St. Louis to succeed Mr. Hilleary. Donald T. Johnstone, assistant manager of the Pump Division, has moved up to Mr. Weom's previous post, with offices in Chicago.

Calgon, Inc. — Dr. Thomas H. Daugherty has been named assistant director of research, with offices at the company laboratories in Pittsburgh. C. E. Kaufman has been appointed assistant director of research for the Calgon affiliate, **Hall Laboratories, Inc.**

Air Reduction Co.—Dr. G. V. Slottman, recently appointed director of research and engineering, has been with the organization since 1934. He has served as manager of the technical sales division and as technical assistant to the vice president in charge of sales.

E. I. du Pont de Nemours & Co.—Arthur F. Bowe, formerly acting manager of the Gulf Coast District Laboratory at Houston, has been named manager of the Eastern District Laboratory of the Petroleum Chemicals Division. Prior to coming with du Pont in 1947 as supervisor of the analytical section of what is now the company's Petroleum Laboratory at Deepwater, N. J., Mr. Bowe was associated with Cities Service Oil Co. at East Braintree, Mass., as a plant and control chemist.

L. O. Koven & Brother, Inc.—H. W. MacIntosh, who has been in charge of Purchasing and Stores Control for the past 29 years, has been named Treasurer, with headquarters at the offices in Jersey City.

Wolverine Tube Division, Calumet & Hecla Consolidated Copper Co. — J. L. Young, Jr., sales representative in Houston, has been promoted to manager of Southwestern Sales. He will headquarter at the Houston office and supervise sales throughout Texas, Arkansas, Louisiana, Oklahoma, and the operation of the company's Mill Depot at 1515 Fulton St., Houston.

Clark Bros. Inc.—W. H. Barnes has joined the technical service staff at the Tulsa, Okla., office. A native of Bartlesville and graduate of the University of Oklahoma with a B.S. in Ch. E. in 1936, he has obtained an M.S. in Ch. E. from M.I.T. He has worked with Standard Oil Co. (Indiana) at Whiting, and with Stanolind Oil & Gas Co., in Tulsa.

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Natasco Corrosion Prevention Service for storage tanks keeps new tanks new and makes old ones give additional years of service. Scientific preparation of all surfaces and application is performed by experienced Natasco Crews.
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Crewmen are trained in the correct preparation of tanks and application of specialized Natasco Products. Many Natasco Foremen have been with the company for from ten to fifteen years and their accumulated knowledge is your assurance of getting a satisfactory and long-life job.
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Manufacturers are called upon to develop and produce the special equipment, used by Natasco, for proper and economical application for Natasco Coatings.
LABORATORY-PERFECTED PRODUCTS
The Natasco Line of laboratory-perfected and field-tested products consists of eighteen products each having a specific application to corrosion problems and conditions. The use of the one — singly or in combination — is dependent upon the conditions in the area or the extent of corrosion on the tanks.
CALL NATASCO TO SOLVE YOUR CORROSION PROBLEMS. WRITE FOR COMPLETE INFORMATION AND COSTS.
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Some Like It Coarse
Some Like It Fine
But All Like Hooker Aluminum Chloride

Hooker Aluminum Chloride Anhydrous is one of the dominant catalysts in the petroleum field. Uniform high purity of this Hooker product accounts for its wide spread popularity. This one catalyst is used for:

1. **Isomerization to manufacture branched paraffins of high anti-knock value, to effect ring closure of aliphatic hydrocarbons, to confer increased aromacity.**
2. **Alkylation or Condensation of paraffins with olefins to manufacture motor fuels; of aromatics with higher olefins or alkyl halides; to synthesize pour point depressants for lubricating oils.**
3. **Cracking of high-boiling hydrocarbons to manufacture gasoline.**
4. **Refining, by decomposition of organic sulfur compounds, by polymerization of gum forming constituents.**
5. **Polymerization of low-boiling hydrocarbons to manufacture motor fuels and lubricants.**

What's more Hooker makes it easy for you to use Hooker Aluminum Chloride in the form best suited to your operations by supplying it in these four forms.

EXTRA FIND GRIND	**An unscreened material, 90 to 95% passing 40 mesh.**
FINE GRIND	**An unscreened material practically all passing 20 mesh.**
COARSE GRIND	**An unscreened material 1 mesh and finer, containing 25% to 35% finer than 20 mesh.**
COARSE SCREENED	**Same as coarse grind but screened to remove 20 mesh and finer.**

SPECIFICATIONS: HOOKER ANHYDROUS ALUMINUM CHLORIDE

Appearance: Grayish crystalline solid.
Analysis:

$AlCl_3$, Min.	98.5 %
Fe, Max.	0.05%
Non-sublimables in air at 950° C, Max.	1.5 %

Research samples of Aluminum Chloride or any of the other Hooker chemicals will be gladly sent when requested on your letterhead.

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Caustic Soda Muriatic Acid Sodium Sulfide Paradichlorobenzene Chlorine Sodium Sulfhydrate

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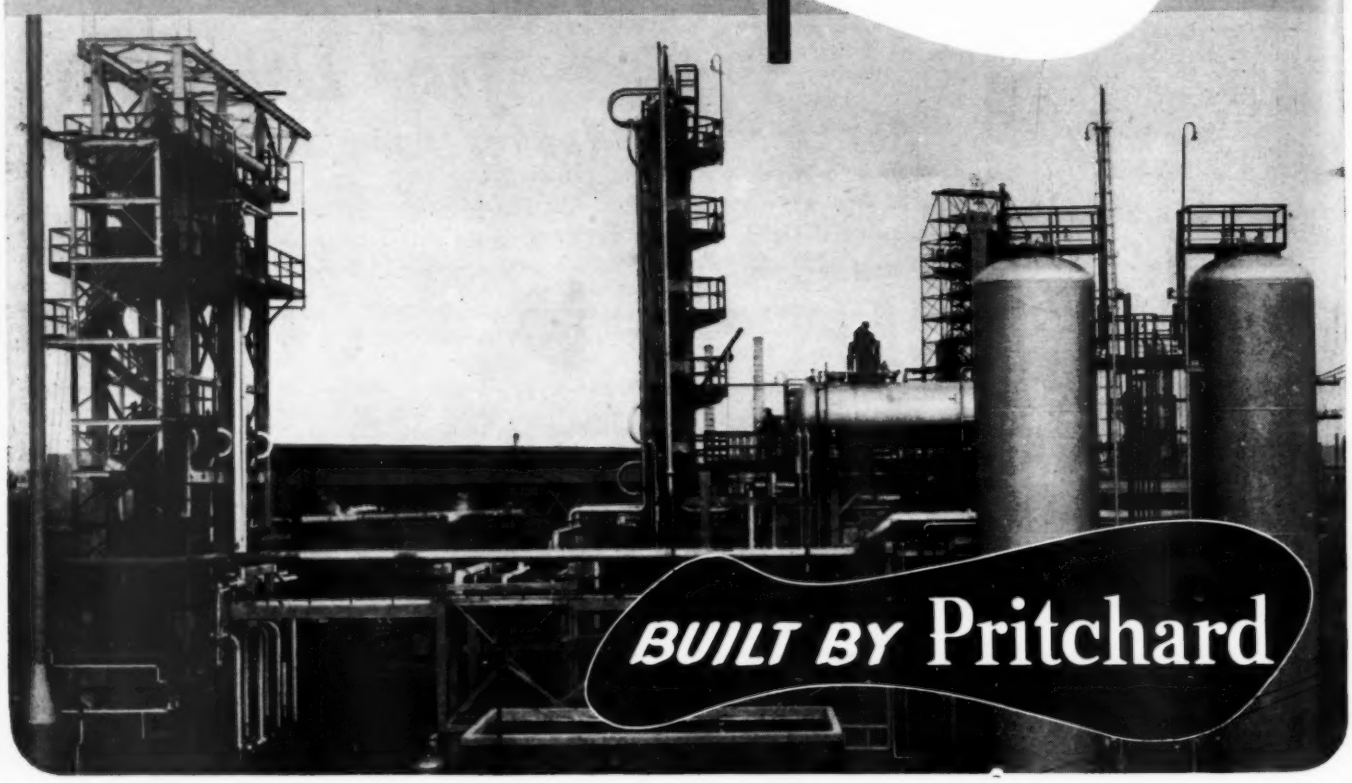

Engineering and building modern designs of time proven processes has long enabled Pritchard clients to get the maximum returns from construction expenditure. One such a project recently completed is the non-selective catalytic polymerization unit shown above. Now in operation for a large east coast refinery, this unit has a capacity of 35,000 barrels a day of debutanized polymer gasoline for use in automotive fuel.

You, too, are invited to benefit from Pritchard experience. Consult Pritchard today for design, engineering or construction services.

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Distillation and Recovery Systems, Thermal Reforming, Cracking, Viscosity Breaking, Alkylation, Isomerization, Lube Processing, Catalytic Reforming, Polymerization, etc.

OIL FIELD PROCESSES

Cycling, Pressure Maintenance, Recovery systems, Crude Stabilization, etc.

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Gasoline and Cycling Plant Operation

Conducted by DAVE THORNTON

Data in answer to questions presented on these pages is supplied through the cooperation of authorities with the equipment and engineering companies of the Natural Gasoline Supply Mens Assn., among others. Readers are invited to submit queries on plant operating problems in their own work.

What factors affect the design of air-cooled equipment?

The design of air-cooled equipment depends chiefly on the five considerations of (1) design air temperature, (2) type of fluid, (3) temperature of fluid, (4) velocity of fluid and (5) fan horsepower.

Care must be used in selecting design air temperature. It must be remembered that the maximum summertime temperature peaks are of very short duration, in all cooling systems there is a capacity for absorbing heat, and it takes time to heat up the fluid and surrounding metal parts. For the Midcontinent area 100° F generally is used. For gas compressor service, the design temperature often may be reduced because heavy loads are in the winter, when air temperature is low.

The type of driving means for the fan also must be considered. Multicylinder engines, turbines and electric motors are used. For engine cooling, the fan often is driven directly from the engine being cooled.

On every installation the amount of finned surface must be balanced against the fan horsepower demand. This is purely an economic consideration in balancing first cost against power and operating costs. It must be considered, however, that it is not necessary to run the fan at full speed throughout the entire year, and as a result the total yearly horsepower requirement can be reduced. The use of dual-speed electric motors has proven very practical, since at half-speed the fan horsepower demand drops to approximately one-eighth the full-speed power requirement.

Temperature control must be considered for most applications. The means most generally used are shutters for reducing air flow, by-pass valves for recirculating systems, control of fan speed and shut down of fans on installations having more than one fan. All these arrangements may be made automatic if desirable.

Air cooling is being used successfully in gasoline plants for cooling engine jacket water and absorption oil, steam condensing and as a column overhead primary condenser. Although it is impractical in many cases to completely condense the still overhead vapor with air-cooled exchangers, it is possible to cool it to, say, 140° F, take reflux at that temperature, and complete condensation of the overhead with evaporative cooling.

There are applications where a shortage of water, or high cost of water, completely changes the normal conception of limitations. As an example, for a portable compressor or an isolated compressor plant, air cooling may be used for intercooling gas between compressor stages to within 15 or 20° of the ambient air temperature and completely eliminate the cost of drilling a water well. In this case the air-cooling equipment is fully salvageable, while such associated facilities as a well and a cooling tower basin could not be re-used elsewhere.—O. L. Smith, The Happy Co., Tulsa.

Discuss the use of aluminum as a protection for thermal insulation and how it is applied.

Aluminum sheeting has been used in refineries for the protection of thermal insulation for many years and has a promising future when the shortage of the metal eases somewhat. In some cases the original metal still is in service after periods ranging up to 20 years.

Aluminum sheet is compatible with most types of standard thermal insulating materials under dry conditions. Under moist conditions, test and service experience have indicated that borosilicate glass wool is one of the best insulations available for use with aluminum. Other thermal insulations which do not cause serious attack are lacquered aluminum foil and certain felt insulations which are applied to the aluminum surface by means of a heavy bituminous or rubber cement.

In the latter case, the heavy adhesive probably acts as a protective coating for the aluminum.

The risk of attack by corrosive insulations sometimes can be greatly reduced by impregnating these insulations with sodium chromate prior to use. The same protection may be secured by painting the surface of the aluminum which will be in contact with the insulation with a suitable paint system. Recommended are two coats of zinc chromate primer with a bakelite base, or two coats of a good bituminous paint.

In some cases, fireproofing and binder materials may contribute to the corrosiveness of the insulating material. Such synthetic resins as phenolics have proved to be noncorrosive and are satisfactory with aluminum.

For the successful application of aluminum, the insulation must be dry; or if wet, must dry quickly. In practice, this means that the aluminum sheet should be applied either just before the insulated object goes "on stream" or sometime after it is "on stream." To reduce the danger of corrosion of aluminum sheet during long delays in construction or during long periods of shut-down, some users have employed a moisture barrier between the insulation and the aluminum.

The aluminum sheet used for thermal insulation covering may range from foil thicknesses to 0.032-in. sheet. The metal sheet normally is wrapped around the insulated structure and secured by aluminum tie wires, aluminum screws, or stainless steel bands. The thickness of the sheet which is used is dependent upon the physical abuse to which the covering will be subjected. If the insulated object is suspended high enough in the air, a thin gauge sheet may be used. Naturally, if the insulated object were to be used as a walkway or given other harsh treatment, a thicker sheet would be necessary.

In most cases, it is not necessary to paint or otherwise maintain aluminum which is used for this purpose, although many companies may wish to apply their own color codes. In especially severe exposures, it may be desirable to apply a coat of aluminum paint for best results.—Engineering Department, Aluminum Company of America.

A light-weight corrugated sheet aluminum with a moisture barrier attached now is being marketed which is made from 0.0055-in. thick No. 2-S aluminum with 0.1875-in. corrugations. The barrier has a base

Trays and Caps Cleaned at 1/10 Old Cost

REMOVING carbonized, gummy deposits and sludge from the trays and bubble caps of a 44 ft. x 3 ft. diameter, 26-tray stabilizing tower was estimated by one refiner to cost near $1,000. But when the job was handled the Oakite way . . by circulating a hot Oakite detergent solution . . . the cleaning job was completed at less than one-tenth this estimated cost. And the tower was put back into service faster.

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Questions and Answers

of 70 lb. kraft paper impregnated with asphaltic compounds and coated with a seal mixture composed of gilsonite, resins, waxes and special asphalts. The jacketing is attached with aluminum screws or metal bands, is supplied in rolls to be cut to size on the job. It may be used over any type of insulation—see "What's New," PETROLEUM PROCESSING, Jan., 1949, p. 89.

What will be the future of the straight-run gasoline, either "sour" or "sweet," as a motor fuel component when octane ratings, both ASTM and Research, go even higher than present-day specifications? This has to do with cycling and natural gasoline plant as well as "absorption" gasoline.

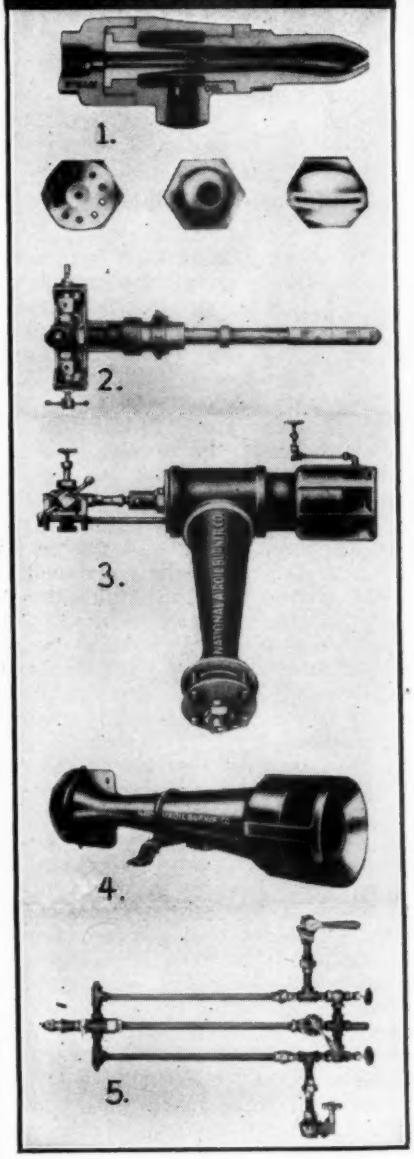
The above question, and the answers following, which pertain equally to natural gasoline plant and refinery operation, have been taken from recorded transcript of the Regional Technical Meeting, Western Petroleum Refiners Assn., at Shreveport, Jan. 28, 1949.

From a somewhat varied experience with it, straight-run gasoline did not have a very good market for a long time. Then during and since the war, until about last (early) spring, it came into its own. It was purchased at about the same price as the best grade of gasoline because of the demand for anything which would burn in cars. But in the last three or four months I find a great deal of reluctance to take on that type of product for the simple reason that cracked or refinery gasoline is available, and I know of a number of new projects that are not being carried through because they see no immediate market.

It looks like that material, unless the "Vitameter" (patented device for injecting into the engine intake manifold an anti-detonant mixture such as alcohol-water, alcohol-water-tetraethyl lead. etc.—D.T.) creates a miracle, will have to find its place in the market or be absorbed by refiners in large quantities of cracked gasoline. The wider use of reforming with the means which are available today, or means which are available in the laboratory at least to some companies, should take care of most of the problems. It will not be sold on the market if there is an available supply of gasoline of higher quality. Except at a big price advantage, its use is not justified.

The problem of the person or company which has distillate production, or condensate, is no different from the problem of the refiners in Kan-

THE *RIGHT* OIL BURNER OR GAS BURNER *FOR YOUR JOB*



TYPE "S-A"

1. (For use where steam is available) *atomizes thoroughly* and *burns completely*, the lowest and cheapest grades of fuel oil and tar, requiring only low oil pressure and temperatures.

TYPE "S-A-L"

2. (Large capacity burner similar to TYPE "S-A-R") is adaptable in combination with powdered coal burners in large boilers.

COMBINATION GAS AND OIL BURNER

3. —the "AIROCOOL" Gas Burner in combination with a TYPE "S-A-R" Oil Burner.

"AIROCOOL" GAS BURNER

4. (Of venturi type) assures low turndown without burnback.

TYPE "S-A-D"

5. (Refuse Oil Burner) burns acids or caustic oils, sludges, asphalts, tank bottoms, polymer oils, heavy petrolatum, organic oil residuums, waste cutting oils, sulphite pulp liquors, etc.

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sas who have a straight-run gasoline of 40 or 45 octane, or in any part of Texas or Louisiana. A good deal of work has been done commercially on reforming(1)—Embie Kaye, Consultant, Tulsa.

I think that when we talk of reforming here, it is simply a matter of economics. Outside of polyforming, anything you do to it results in less volume than you started with, and it is simply a matter of cost there. It is going to be sold as is for some price, or processed or reformed in some manner at a cost which will justify the processing.

On the other side of the picture the main difference, I believe, over the older straight thermal reforming also is in the utilization of the light gases which may be formed by the process. As you lose the volume it is going to make something. Part of the economics depends on the individual case of what you do with the loss from the gasoline volume. So if you can form a pretty general statement, the old laws of economics still seem to hold. If you get more to the "squeal" utilized the other ways, that has to be taken into account as well as the loss taken on the reforming steps.—George M. Brooner, Perco Division, Phillips Petroleum Co., Bartlesville.

What is the cause of explosions in engine crankcases and what can be done to prevent them?

Several engine builders in the past few years have experienced a series of crankcase explosions on their engines in the field. In some cases these have been minor in nature, but in others several operators have been seriously burned and, in at least two instances, there have been fatalities.

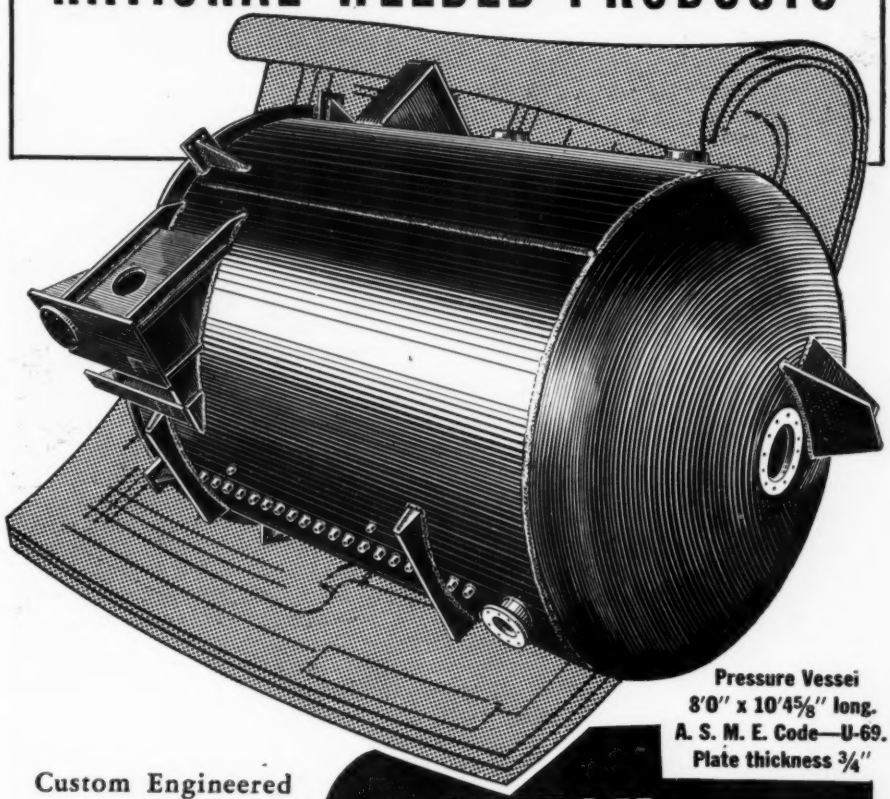
A crankcase expolsion naturally requires two conditions before it can occur. First, there must be a combustible mixture present in the crankcase. Second, there must be some means of igniting this combustible mixture.

The ignition always is caused by some localized hot spot, such as a burned-out bearing, a stuck piston pin, a scored piston, or any frozen bushing, even an auxiliary drive. The heat from this localized hot spot is sufficient to set off an explosion.

As to how such a combustible mixture is formed, it is rarely found that a combustible mixture has developed in the crankcase because the mixture supplied as the engine fuel (and present in the crankcase as blow-by) was too rich. Therefore,

(1) See PETROLEUM PROCESSING for February, 1949, p. 177, for discussion of reforming natural gasoline.

NATIONAL WELDED PRODUCTS



Pressure Vessel
8'0" x 10'4⅝" long.
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Plate thickness ¾"

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Custom Engineered by NATIONAL means reliable and durable equipment for the chemical, processing and petroleum industries. All manufacturing operations such as forming, welding, stress relieving and machining are performed within our own plant—under the constant protection of X-ray and manual inspections.

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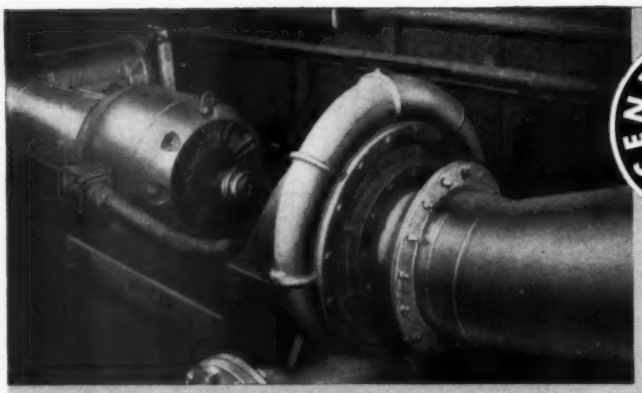
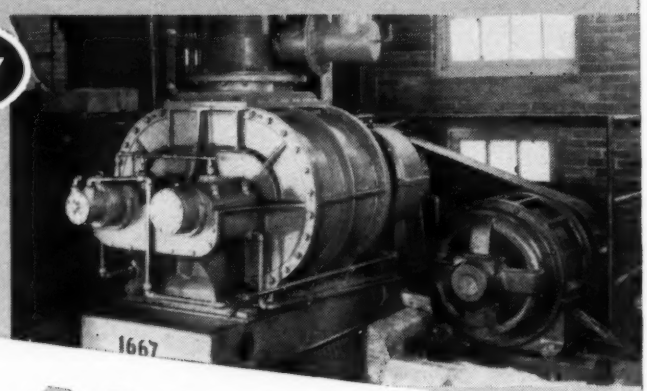


R-C Centrifugal Blower, type OIB, in foundry service. Capacity 6,000 CFM, at 21 oz. pressure.

ROTARY



R-C Rotary Blower, type RCD, capacity 6,200 CFM.

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If you are in doubt about whether Centrifugal or Rotary Positive units will do the best job of handling cupola air on any specific application, you can obtain an unbiased answer from R-C *dual-ability*.

Because we build both types, in wide ranges of sizes and designs, we can make sound comparisons and can recommend without prejudice the units whose capacities, pressures, drives and other characteristics deliver the best performance.

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Questions and Answers

the only means of making the crankcase vapors combustible is by the introduction of air. This usually happens when a crank door or cover plate is removed immediately after shutting down. The admission of a fresh air charge by this removal is sufficient to cause an explosion.

We have urged all of our customers to instruct their operators *never* to remove a crankcase cover plate immediately after shutting down. The engine always should be cooled down at least 10 to 20 minutes before removing any cover.

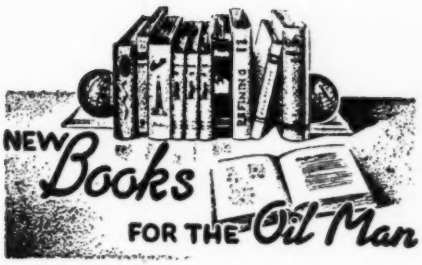
It therefore also follows that the circulation of air in a crankcase for ventilation purposes is a bad practice. It will provide sufficient oxygen to permit an explosive mixture to form. The instant, then, that a source of ignition develops, an explosion can occur.

We believe these precautions always should be taken, for one can never be certain when this might not happen.—Service Department, Cooper-Bessemer Corp., Mt. Vernon, Ohio.

Would it be practical to add minute quantities of radioactive materials to tetraethyl lead fluid to identify source of supply and is it now the practice of manufacturers to add identifying materials?

There are many materials which could be added to tetraethyl lead fluid by which the fluid's source could be identified, providing no two manufacturers used the same material. However, du Pont considers considers tetraethyl lead a commodity like other petroleum additives and we are not interested in tracing its course in gasoline commerce, providing necessary safety regulations are observed. We, therefore, have no plans for using any identifying agents.—Ray E. Miller, Petroleum Chemicals Division, E. I. du Pont de Nemours & Co., Wilmington, Del.

Amplifying Mr. Miller's answer, it has been learned through other sources that there are numerous less expensive and potentially less dangerous ways than radioactive compounds of adding tracer materials to TEL fluid, such as various dyes. These materials may be chosen so as not to affect gasoline quality or injure the motor. It appears identifiers are not in use by U. S. manufacturers. England is using gasoline tracers as a part of its rationing program; a red dye which can be filtered out without great difficulty, even with an ordinary gas mask, and a secret chemical detectable with litmus paper, according to Warren C. Platt (NPN July 21, p. 23).—Dave Thornton.



Conservation of Oil and Gas Compiled in Legal History

Conservation of Oil & Gas, A Legal History—1948, edited by Blakely M. Murphy; 6 x 9¼ in., xviii + 745 p., stiff cloth binding, indexed. $3.00. Order direct from American Bar Ass'n. 1140 No. Dearborn St., Chicago 10, Ill.

Petroleum processors should find much of value and interest in *Conservation of Oil & Gas, A Legal History*—1948; because, if for no other reason, the conservation of crude is an important economic factor in successful refinery operation.

This work is not a technical treatise of the regulations concerning oil and gas production. Rather, it is a manual that will be useful to oil company executives, legal counsels, legislators, judges, and private citizens who want to know more about how to preserve one of the nation's most precious mineral heritages.

The book is divided into four major sections. Part I deals with the fundamental concepts of the petroleum reservoir. It was prepared in final form by legal writers, but is based on partial research by a number of leading petroleum engineers. Part II describes the background of legislative, administrative, and judicial activities pertaining to oil and gas conservation in the 35 oil-producing states.

Part III presents a summary of the evolution of the Interstate Compact to Conserve Oil and Gas and the methods by which the Interstate Oil Compact Commission carries its programs into effect. Part IV brings together a series of discussions on how the federal government has fitted into the overall scheme of oil and gas conservation.

The volume is a result of a project by the Mineral Section of the American Bar Ass'n. Editor Murphy has had a long legal career in the petroleum industry and presently is serving as Executive Secretary of the Legal Committee of the Interstate Oil Compact Commission. Prominent oil attorneys acted as the writers of the various chapters. In Part I, they received technical advice and assistance from such men as Dr. John C. Calhoun, Jr., and Dean W. H. Carson, both of the School of Petroleum Engineering, University of Oklahoma. The paper also was read by Dr. H. H. Kaveler, assistant to the vice-president, Phillips Petroleum Co. L. E. Elkins, chief engineer, Stanolind Oil & Gas Co.; N. Van Wingen, Department of Petroleum Engineering, University of Oklahoma; and Gorden H. Fisher, chief petroleum engineer, Gulf Oil Corp.

Unless otherwise indicated, copies of all books reviewed here may be ordered from the Reader's Service Department, Petroleum Processing, 1213 West Third Street, Cleveland 13, Ohio, for the price listed, postpaid. Ohio purchasers please add 3% tax. NOTE: publisher's prices are subject to change without notice.

Lukens Publishes Reference On Steel Plate Fabrication

Steel Plates and Their Fabrication, edited by Lionel S. Marks; 6 x 9 in., 408 pages, stiff cloth binding, illustrated, indexed. $5.00. Order on company letterhead direct from the publishers, Lukens Steel Co., 106 Highway Bldg., Coatesville, Penna.

A good reference book for designers and engineers who work with steel plate and with structures of which steel plate is a part, *Steel Plates and Their Fabrication* contains extensive data on: 1) physical properties of carbon and low-alloy steels, with charts and tables indicating their behavior under sustained and repeated loadings and their resistance to abrasion, corrosion, and temperature changes; 2) physical and mechanical properties, plate and head sizes on nickel-, stainless-, inconel-, and monel-clad steels; 3) general and historical information on open-hearth steel making, effect of plate widths on fabrication costs, fabricated assemblies, pressure vessels, and tanks.

Included for handy reference are over 100 pages of tables and other data taken directly from the *Mechanical Engineers' Handbook.*

The book was prepared under the editorial supervision of Lionel S. Marks, Professor Emeritus in Mechanical Engineering of Harvard University, and editor of the *Mechanical Engineers' Handbook.* Most of the sections were written by members of the staff of Lukens Steel Co. and its subsidiaries.

Book Review Briefs

Bibliography on Water and Sewage Analysis, Special Report No. 28, by Ben H. Weil, Poagie E. Murray, George W. Reid, and Robert S. Ingols; 5¼ x 8½ in., viii + 215 pages, stiff cloth binding, indexed by author references, $4.00 (1948). Order from State Engrg. Experiment Station, Georgia Institute of Technology, Atlanta.

Coding of Thermocouple Wire and Extension Wire, Tentative Recommended Practice RP 1.1; 8½ x 11 in., four pages, $1.00.

Manometer Tables, Tentative Recommended Practice RP 2.1; 8½ x 11 in., 32 pages, $2.00.

Order direct from Instrument Society of America, 1117 Wolfendale St., Pittsburgh 12, Pa. Check in New York Bank funds must accompany the order. These booklets are free to members of ISA.

Patent Law for the Executive and Engineer, 2nd Edition, by Harry A. Toulmin, Jr.; 5¼ x 7¾ in., 231 pages, stiff cloth binding, illustrated, $2.95. Research Press, Inc., Dayton, Ohio.

How to Keep Invention Records, by Harry A. Toulmin, Jr.; 5 x 7½ in., xii + 78 pages, stiff cloth binding, illustrated, $2.50. Research Press, Inc., Dayton, Ohio.

The Life Hazards and Nature of the Products Formed When Chlorobromomethane Extinguisher Liquid is Applied to Fires, Bulletin of Research No. 42, August, 1948; 6 x 9 in., 60 pages, paper binding, illustrated. Order direct from Underwriters' Laboratories, Inc., 207 East Ohio St., Chicago 11, Ill.

MEETINGS . . . for the Oil Man

APRIL

4-7, American Petroleum Institute, Division of Refining, Shamrock Hotel, Houston.

11-13, American Society of Lubrication Engineers, Hotel Statler, New York.

11-14, National Assn. of Corrosion Engineers, 5th Annual Conference and Exhibition, Netherlands-Plaza Hotel, Cincinnati, Ohio.

13-15, National Petroleum Assn., Hotel Cleveland, Cleveland.

20-22, Natural Gasoline Assn. of America, Texas Hotel, Ft. Worth, Texas.

MAY

9-11, Liquefied Petroleum Gas Assn., Meeting and Trade Show, Palmer House, Chicago.

12-13, Instrument Society of America, 4th Annual Spring Meeting, Royal York Hotel, Toronto, Canada.

JUNE

5-10, Society of Automotive Engineers, Summer Meeting, French Lick Springs Hotel, French Lick, Ind.

9, Chemical Market Research Assn., Annual Business Meeting, Biltmore Hotel, New York.

27-July 1, American Society for Testing Materials, 52nd Annual Meeting, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

SEPTEMBER

12-16, Instrument Society of America, Annual Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.

14-16, National Petroleum Assn., Hotel Traymore, Atlantic City, N. J.

18-23, American Chemical Society, 116th national meeting, Atlantic City, N. J.

OCTOBER

10-14, American Society for Testing Materials, First national West Coast Meeting, Fairmount Hotel, San Francisco, Calif.

Personals

H. R. Boehmer is manager of the Sugar Creek refinery of Standard Oil Co. (Indiana), succeeding the late **R. E. Beard.** A graduate of the University of Wisconsin, he joined Standard in 1915 at the Whiting refinery and was transferred to Sugar Creek as chemist

Mr. Boehmer

Mr. Cash

in 1916. He became superintendent there in 1920 and was made general superintendent in 1946.

R. M. Cash succeeds Mr. Boehmer as general superintendent at Sugar Creek. An alumnus of Iowa State College, his first job with Indiana Standard was in 1926 as laboratory assistant at Sugar Creek. After advancing to foreman of the asphalt department in 1932 and general foreman in 1945, he was made superintendent of the process division in 1946.

* * *

Edwin F. Nelson, vice president, Universal Oil Co., Chicago, has received a citation award from the College of Engineering, University of Wisconsin, for his contributions to chemical engineering in the petroleum industry, in connection with the activities of UOP. The award was presented at the Engineers Centennial Day Dinner, in Madison, March 15. Mr. Nelson graduated from the College of Engineering of University of Wisconsin in 1924, and has been associated with UOP since 1926.

* * *

H. S. Bell, formerly president of H. S. Bell, Inc., petroleum engineers, is now associated with the Frederick Snare Corp., New York, engineering contractors. Mr. Bell is a graduate of Princeton University in general engineering and from 1912 to 1918 was with the Vacuum Oil Co. (now Socony-Vacuum) serving for part of that time as acting chief engineer supervising an extensive plant expansion program. He was later with Sinclair Consolidated as advisory engineer and later organized and managed the Oil Division of M. W. Kellogg Co.

In 1923 he organized his own company to serve as design and construction engineers for the petroleum, gas and allied industries, their work embracing projects in seven countries. Mr. Bell is the author of "American Petroleum Refining," now in its third Edition.

The Frederick Snare Corp. is the engineering and construction contractor for the new 35,000-bbl. refinery of Sinclair Oil and Refining Co. at Puerto la Cruz, Venezuela.

* * *

George A. Lloyd is assistant manager of the Public Relations Department of Esso Standard Oil Co. He attended Newark, N. J., University and served successively in manufacturing and development operations at the Bayway refinery, becoming head of the light oil treatment department in 1933. He was named public relations representative for the New Jersey refineries in 1945, and was transferred to New York in 1946 to assist in the expanded activities of the company's overall public relations department.

Mr. Lloyd

* * *

Raymond H. Crowe has resigned from Stanolind Pipe Line Co. to go with Stone and Webster Service Corp., New York. He will head an engineering staff which will certify construction by Fish Engineering Corp., Houston, of the Transcontinental Gas Pipe Line Co.'s line from southern Texas to New York City. His staff will have headquarters in Houston. He joined Stanolind in 1933 and has filled a number of engineering assignments.

Mr. Crowe

F. S. Clulow, vice president in charge of manufacturing, Shell Oil Co., Inc., has been appointed a director of the company. He joined Shell in 1920, becoming assistant superintendent of the Martinez, Cal., refinery. He later became manager of the former East Chicago refinery and manager of the manufacturing department and in 1938 was made vice president in charge of manufacturing.

Mr. Clulow

* * *

Dr. C. Rogers McCullough, of Monsanto Chemical Co.'s general development department, has been awarded the President's Certificate of Merit in recognition of his wartime scientific services. He directed various phases of rocket propellant and motors work for the National Research Defense Committee and also did development work on styrene for the Office of Rubber Reserve.

* * *

Lloyd E. Elkins, Stanolind Oil & Gas Co., Tulsa, is the new chairman of the Petroleum Division, American Institute of Mining and Metallurgical Engineers.

* * *

Harry L. Moir is the 1949 Vice President for Fuels and Lubricants of the Society of Automotive Engineers. A native of Glasgow, Scotland, he attended Northwestern University and joined Pure Oil Co., where he has served for 15 years. He organized and managed the mechanical laboratory in Chicago and became assistant chief products engineer. In 1942 he was made technical advisor to the marketing department and, recently, manager of the service departments in the marketing division.

Mr. Moir

* * *

William L. Stewart, Jr., San Francisco, executive vice-president, Union Oil Co. of California, has been re-elected a director of Stanford Research Institute. **W. W. Valentine,** Los Angeles, president of Fullerton Oil Co.; **S. D. Bechtel,** San Francisco, president of Bechtel Corp., and **R. G. Follis,** San Francisco, vice chairman

of the board, Standard Oil Co. of California, are newly elected directors. The board of directors of Stanford Research Institute has been increased from 11 to 29 members, to keep pace with the Institute's growth as a center of applied research for western industry.

* * *

Dr. H. G. Burks, Jr., was elected a vice president of Esso Standard Oil Co. and will be contact director for the manufacturing, supply and transportation and chemical products departments. He succeeds **J. R. Carringer,** vice president, who is to retire May 1 after 45 years of service in petroleum manufacturing.

Mr. Burks

Mr. Carringer

Dr. Burks joined the company in 1924, after receiving his doctorate at Massachusetts Institute of Technology. A veteran of World War I, he served with the PAW in World War II. He was elected a director in 1943 and has been general manager of manufacturing for the past year.

M. W. Boyer, vice president and director in charge of Louisiana manufacturing operations, succeeds Dr. Burks as director of all manufacturing operations for Esso. He joined the Esso Baton Rouge laboratories in 1927 after serving as an assistant in the Research Laboratory of Applied Chemistry in Massachusetts Institute of Technology. He became general superintendent of the Baton Rouge plant in 1933.

Mr. Boyer

Mr. Thiede

Cecil Morgan, associate general counsel in the Law Department, was elected a vice president and will head Louisiana manufacturing operations and crude oil purchasing.

W. F. Thiede is manager of East Coast manufacturing operations for Esso Standard Oil Co. and **P. E. Kuhl** assistant manager.

Afton D. Puckett has been promoted to district laboratory coordinator in the Petroleum Chemicals Division of the Du Pont Co. Born in Texas, he graduated from Oklahoma A. & M. College in chemical engineering in 1936. Before going to Du Pont about a year ago he had been with the Bureau of Standards at Washington and in the Bureau of Mines experimental station at Bartlesville and the Tide Water Associated Oil Co.,

Are You Interested in Corrosion Short Course?

Engineers and management specialists interested in attending a short course in corrosion engineering are invited to write **Nathan Schofer,** at Cities Service Refining Corp., Tutwiler Refinery, Lake Charles, La. Mr. Schofer is chairman of a committee named by the South Central Region, National Assn. of Corrosion Engineers, to get a consensus on the proposed course, and if sufficient interest is evidenced, make arrangements with a university engineering school to hold it this year.

Letters expressing interest should define the specific aspect of corrosion in which the writer is interested, forecast the number likely to attend, the most suitable time it should be held, and give any other pertinent comments.

While specific organization has not been defined and will not be determined finally until expressions from those interested have been considered, plans include possible use of a series of lectures originally given at a short course on corrosion at the Stevens Institute of Technology and presentation of subjects by qualified specialists from industry, with or without supplementary assistance from the teaching staff of the university selected.

The one or two weeks' course may be attended by about 200, and fees covering cost of the program are contemplated.

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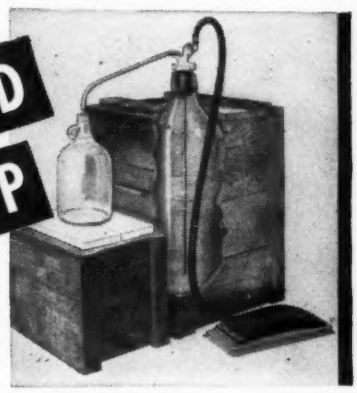

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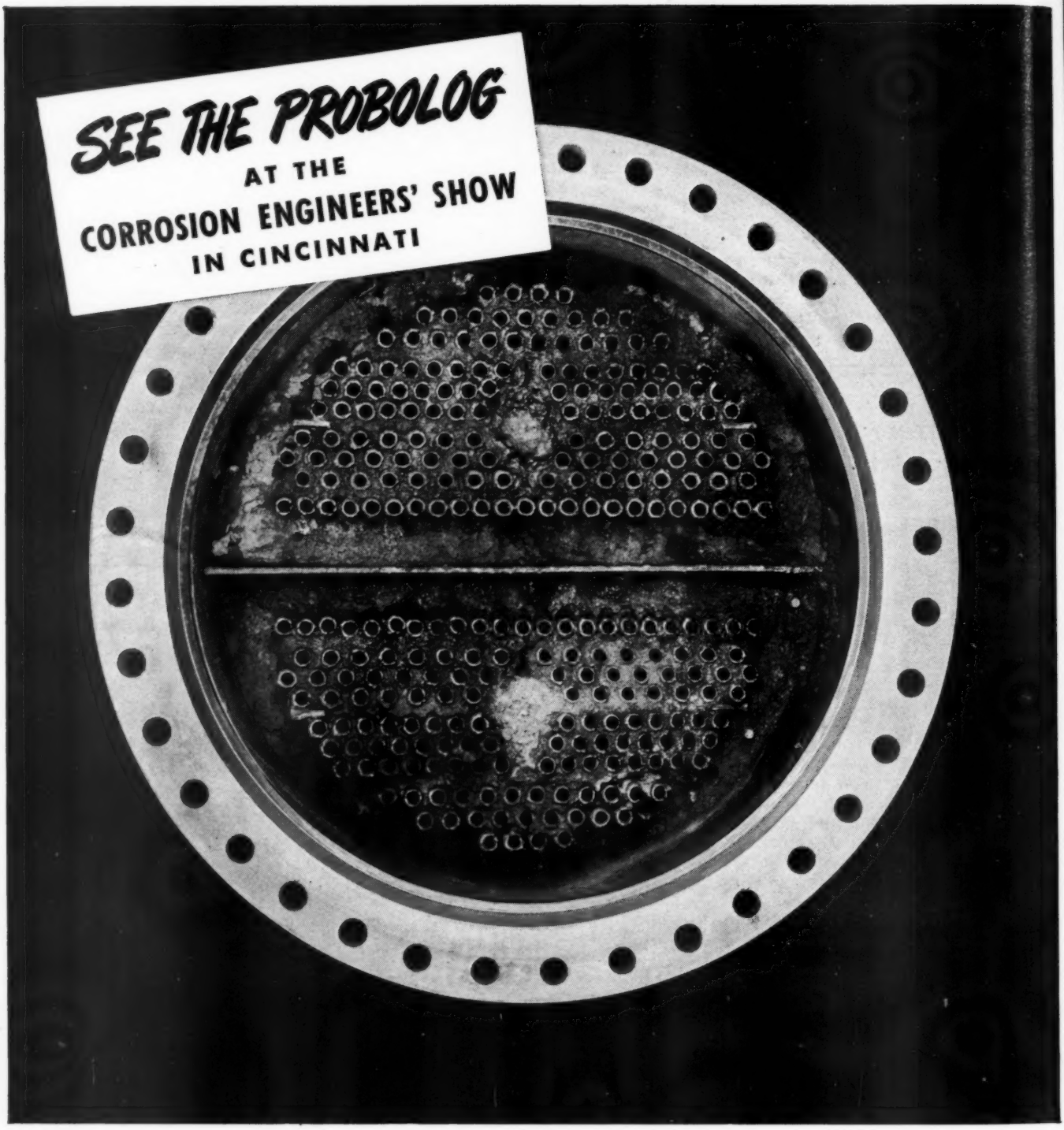

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in Oklahoma. With Du Pont he was formerly in charge of studies of antiknock properties of motor fuels in the Combustion Engineering Laboratory.

John N. C. Cameron is manager of the Gulf Coast district laboratory of the Petroleum Chemicals Division of Du Pont. Born in Canada he has spent nearly all his life in the Houston area, studying at Texas and Houston Universities, receiving a degree in chemistry at the latter. He is a one-time holder of the Houston amateur golf championship.

* * *

Dr. Heinz Heinemann is a project director on the staff of Houdry Process Corp., after serving in a research capacity with Attapulgus Clay Co. He studied in scientific schools in Germany and received his doctorate at the University of Basle, Switzerland, in 1937. He has been connected with refining companies in the Southwest and his research career has been chiefly in catalytic refining.

Dr. Heinemann

* * *

Harry T. Van Horn has returned to Socony-Vacuum Oil Co.'s technical service laboratory in Brooklyn, following three years at Rutgers University as a Socony-Vacuum research fellow in ceramics, where he completed requirements for his doctorate.

* * *

R. T. Sanderson is associate professor of chemistry at the University of Florida, Gainesville. He was formerly with The Texas Co.

* * *

M. H. Arveson is technical director of Indoil Chemical Co., recently organized to take over the activities of the chemical products department of Standard Oil Co. (Indiana). He was formerly senior technologist in the department.

* * *

H. G. Cutforth is a chemist in the physical division of Phillips Petroleum Co., Bartlesville. He was formerly with Rohm & Haas.

* * *

Hart H. Fleming, National Foam System, Inc., Philadelphia, has resigned as president and director of the company. Mr. Fleming will act in a consulting capacity in sales and research. **Fisher L. Boyd,** who has acted as president, and treasurer since its inception, has resumed his former duties.

Joseph A. La Fortune, Tulsa, executive vice president of Warren Petroleum Corp., received the Honorary Doctor of Law degree from Notre Dame University at the recent commencement exercises. He has been for many yars on the associate board of lay trustees.

* * *

J. E. Marsland is senior technologist in the Head Office Manufacturing Department of Shell Oil Co., Inc. A graduate of California Institute of Technology, he received his M.S. from Massachusetts Institute of Technology. He started with Shell in 1933. He was later transferred to San Francisco as technical assistant becoming senior technologist in 1944. In 1945 he was made chief technologist at Wilmington.

* * *

Dr. Emery N. Kemler is associate director, in Houston, of the Southwest Research Institute. He succeeds **Dr. John V. Pennington** who is on leave of absence from the Institute engaged in special work. Dr. Kemler studied at University of Kansas and University of Pittsburgh, was

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Young Sales Corporation
John Zink Burner Company

a production engineer for Gulf Oil Corp., has held various research positions and lately was acting director of research at New York University.

* * *

R. A. Andresen is assistant chief engineer of the Manufacturing Department, Eastern Division, California Texas Oil Co., Ltd., and will have headquarters in New York. He will handle refinery engineering and construction projects east of Suez and in the Eastern Mediterranean. A graduate of the University of California in 1935, he joined Standard of California as a process engineer. From 1938 to 1948 he was chief engineer of the Caltex refinery on Bahrein Island.

* * *

Dr. Ralph L. Nuttall is on the staff of the National Bureau of Standards where he will do research on the thermal conductivity of gases at elevated temperatures and pressures. He studied at the University of Utah and continued graduate work at Yale, where he was awarded the du Pont Fellowship in physical chemistry for 1947 and 1948, receiving his Ph.D.

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EDITORIAL VIEWPOINTS...

Opinions and Comments on Current Topics

Drawing Jet Fuel "Specs"

THE METHOD BEING USED by the Armed Services to arrive at their specifications for fuels for jet-propelled aircraft is not likely to bring about the close coordination between the military agencies and the oil companies which is essential to best results.

The clearing house for the new proposed specification for the JP-3 fuel has been the Aircraft Industriales Assn. of America, Inc., an organization predominantly of aircraft engine and framework manufacturers with headquarters in Washington. This agency sponsored the meetings at which the new standards were proposed, and submitted the report on that meeting to the interested military agencies. It circularized selected oil companies for their comment on the proposed new specifications, making up the report on the survey and sending it to the military. Under such an arrangement it does not seem that the oil companies can be insured that the views on the subject of specifications which are peculiar to the producers of the fuel can be accurately passed on to those who make the final decisions.

As of the present, only the military requirements for jet fuels have to be met and these are for small quantities, even as compared with conventional fuels for military use. Supplying them will not be difficult for the oil companies. However, it is impossible now to foresee the future developments that may take place in the jet-propelled type of aircraft.

Under these circumstances, is not the present the time for close coordination between the oil companies and the military in the study of jet fuels? The objectives should be that the fuels adopted be of a type that will place the least possible restriction on the refiner's output of standard volume products and also of a type that can be supplied by the largest possible number of refiners, while at the same time providing the required serviceability.

Working out a program with these objectives calls for direct and close coordination between the military agencies and the nation's refiners. The liaison agency also should be the American Petroleum Institute or some exclusively petroleum industry technical society.

The Rising Cost of Research

THE RISING COSTS OF INDUSTRIAL RESEARCH, concurrent with its great expansion in recent years, raise the question as to whether the law of diminishing returns may not be starting to take hold there, Dr. Wilson, chairman of the board, Standard Oil Co. (Indiana), recently told the Industrial Research Institute.

We recognize that we must expand research if progress is to continue, he stated, but some time we are going to reach a place where we cannot afford to expand further because the rest of the operations will not be able to carry the load. Some day there will not be enough yield for each dollar expended in research. Research has done a fine job in studying the costs of industrial operations of all sorts, and Dr. Wilson believes the time has come when it must give some attention to cutting its own costs. Physician, heal thyself, he expressed it.

Dr. Wilson directed his discussion of the subject at industrial research in general. His experience has been largely in the petroleum field, both in research work and, as head of a large oil company, in the general supervision of a large and growing research department. His remarks without question are pertinent to petroleum research, which has expanded greatly in the post-war period in scope and nature as well as in physical facilities and personnel engaged.

(The talk by Dr. Wilson entitled "The Attitude of Management Toward Research," is available in reprint form by writing the Public Relations Dept. Standard Oil Co. (Indiana), 910 S. Michigan Ave., Chicago.)

Making Their Own Silver Lining

THE CLASSIC EXAMPLE of high efficiency in the industrial utilization of raw materials is the packing industry, which has been praised for conserving all the pig but the squeal. However, the petroleum refiners in Los Angeles are preparing to go this one better, by converting what has been a contaminant in their gaseous waste, and a contributing factor in the smog problem there, into a useful chemical product.

The seven large refiners in the Los Angeles area, and the small refiners through their association, are taking an active part in the program to eliminate the eye-irritating conditions which, together with reduced visibility, are the principal nuisances of the smog encountered there. In addition, they are taking several steps in their individual plants to reduce greatly the volume of sulfur dioxide discharged into the air through the burning as fuel of the off-gases from their catalytic cracking operations. Since no practical methods are yet known for extracting sulfur dioxide from stack gases in the low concentrations found, the refiners have adopted the means of extracting the hydrogen sulfide from the gases from the catalytic crackers before using them for fuel. They are spending several millions for the extraction units.

Hancock Chemical Co., a subsidiary of Hancock Oil Co., is now building a plant which will take the hydrogen sulfide extracted at the various refineries and convert it to elemental sulfur, a product used in agriculture, and manufactured into sulfuric acid. The free sulfur thus produced, it is said, will be equal in quantity and competitive in price to that coming from sulfur plants in Texas and Louisiana.

This method of producing elemental sulfur is not entirely new. There are indications, however, that the program undertaken by the Los Angeles refiners may stimulate the commercial manufacture of sulfur from petroleum and natural gas hydrocarbons. Thus we would have another facet of the petrochemical industry, evolved in part from the operating headache of the refiners.

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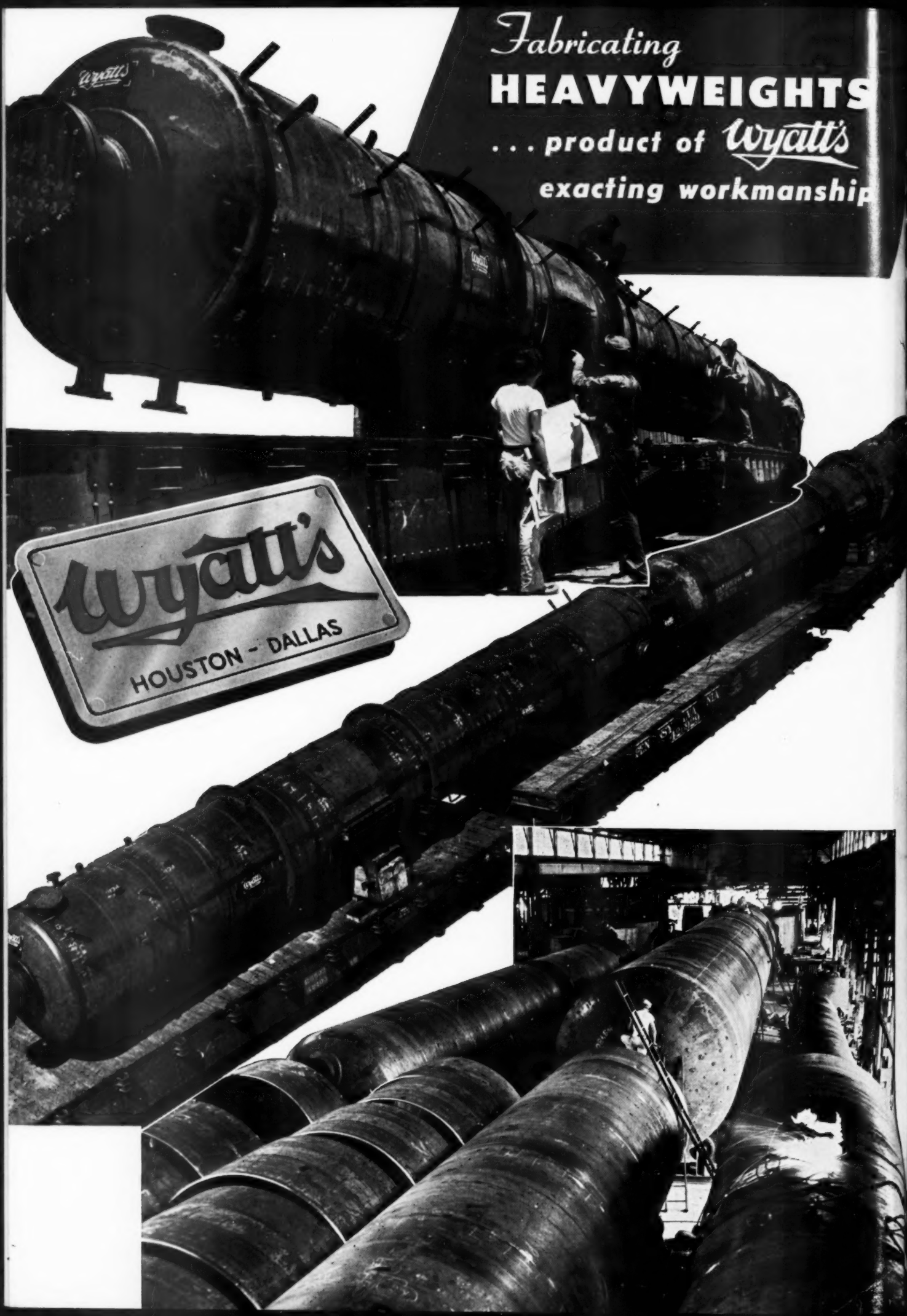
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